

Mangabey diphyly revisited: morphometric analysis of papionin cranial shape supports the molecular phylogeny. M. SINGLETON, Department of Anatomy, NY College of Osteopathic Medicine, Old Westbury, NY 11568.

Relationships within the Old World monkey tribe Papionini are a source of continuing controversy. Traditional morphological classifications (e.g., Napier & Napier 1985) make mangabeys, *Cercocebus* and *Lophocebus*, monophyletic. Molecular studies (e.g., Harris & Disotell 1998) have consistently found that *Cercocebus* is the sister taxon to *Mandrillus*, with *Lophocebus* more closely related to *Papio* and *Theropithecus*. Fleagle and McGraw (1999) identified postcranial and dental characters supporting the molecular phylogeny, but the detailed cranial similarities differentiating the mangabey and baboon grades persist. Accepting the molecular phylogeny, this extensive homoplasy is most readily explained by parallelism due to allometric effects.

To evaluate this hypothesis, a geometric morphometric study of papionin cranial shape was undertaken. Forty-four 3D craniometric landmarks were recorded on male and female adult specimens of all papionin genera including *Macaca*. Specimens were aligned via a GLS Procrustes superimposition and scaled to unit centroid size (*Morpheus*, Slice 1998). Aligned coordinates were subjected to principal components analysis and scores from the first 10 principal components (PCs), summarizing 90% of total shape variance, were retained as shape variables. The first PC, accounting for 67% of shape variance, is significantly correlated with centroid size ($r = -0.96$, $p < 0.0001$). Remaining PCs are not significantly correlated with size and summarize shape differences between subsets of taxa. UPGMA cluster analysis of Procrustes distances reproduces the traditional phylogeny. By contrast, analyses based on the 10 shape variables approximate the molecular phylogeny. Analyses excluding the first PC, the size-correlated component of cranial shape, maximize distances between clades. Results suggest the initial hypothesis is partially correct: allometric scaling of cranial shape does account for homoplastic similarities between like-sized members of distinct papionin clades. It also obscures subtle morphological features reflecting shared ancestry. These features are explored graphically using thin-plate splines.

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Earlier peak values indicate more rapid regression. A. SINIARSKA and N. WOLANSKI, Center for Scientific Research and Postgraduate Studies, Merida, Yucatan, Mexico and Institute of Ecology of the Polish Academy of Sciences, Warsaw.

Previous studies revealed that the earlier the termination of progressive development of a certain trait, the earlier the decline begins. The tempo of development, age at peak value, and velocity of regressive changes may be related to each other through a specific, individual, self-regulating mechanism, as well as through lifestyle and external environmental conditions. Thus, differences between various populations, and between generations

within a population may depend on changes in both the natural and sociocultural environments. For example, although the sense-of-equilibrium was important in hunting societies, in sedentary societies this trait may start its regression earlier. Biological functions, which are necessary for physical activity well into old age or are capable of being trained for physical efficiency, reach peak values later and show much lower regression values than other less-important functions. Hand shape and strength, and mandible dimensions are important lifelong characteristics. The same is true for accuracy of throwing and stamina - persistence fitness; therefore these functions remain unchanged for a long time. It is possible that any stimulation of the progressive development of a particular trait may cause retardation of the onset of regressive changes. We suggest that "life vigor," which weakens with age in human organisms, might be the factor influencing the intensity of developmental changes -- both progressive and regressive ones. If the regression starts earlier in one's life, it might be more rapid and intense because the individual's "life potency" has been greater. Any delay in regressive changes might be possible because of long-lasting stimulation of progressive development allowing a trait to achieve a high level of development as late as possible.

Disease patterns of residents of the Monroe County Almshouse compared to those observed in the City of Rochester, NY during the early nineteenth century. J.E. SIRIANNI, SUNY at Buffalo, Buffalo, NY 14261.

A portion of a cemetery associated with the Monroe County Almshouse was accidentally unearthed in 1984 while the county department of parks was expanding a public facility in Rochester, New York. After the Rochester Museum of Science excavated the cemetery, the 300 skeletons were loaned to the University at Buffalo for analysis. Associated historic records from Monroe County and the City of Rochester provide valuable resources for comparing not only demographic profiles, but also health assessments and disease patterns during the nineteenth century. The Town of Brighton Vital Records document the name, age, sex, cause of death, and occupation of 187 adults living at the Monroe County Almshouse during the period from 1847 to 1850. Interment records for the Mt. Hope Cemetery provide similar data for the greater Rochester population. The purpose of this study is to compare the disease specific mortality reported for the almshouse with that of the general population during 1847-1850.

In each of the four years under investigation, tuberculosis was the major cause of death and its incidence in the skeletal population mirrors that seen in the general population. Although gastro-intestinal diseases comprise the second leading cause of death in both groups, typhus and cholera occur more frequently in the almshouse. During 1847, typhus accounts for 38% of the deaths at the almshouse and 1.3% in the general population. The cholera epidemic of 1849 had a greater impact among the residents of the almshouse (32.1%)

than those living in the Rochester area as a whole (18.4%). However there is evidence that many of the cholera deaths were concentrated in the poorer neighborhoods of the city.

Diseases associated with overcrowded, squalid living condition are not only prevalent at the almshouse, but may have exacted a greater toll on those who were already weakened and at risk by the stresses of poverty. The living conditions and disease-specific mortality documented for the Monroe County Almshouse are compared to other poorhouses in the United States during the nineteenth century.

Periodicity of repetitive linear enamel hypoplasia in Asian and African apes. M.F SKINNER, Department of Archaeology, Simon Fraser University, Burnaby, B.C., V5A 1S6, Canada.

Repetitive linear enamel hypoplasia (rLEH) is ubiquitous among apes from Africa and Asia but etiology and periodicity are unknown. Research is designed to show periodicity of rLEH among West African chimpanzees, gorillas and Bonobos as well as Bornean and Sumatran orangutans from collections in Europe. Two methods were employed. In the common chimpanzees and gorillas, the space between adjacent LEH grooves on teeth with two or more episodes was expressed as an absolute measure and as a ratio of complete unworn crown height. In the orangutans and Bonobos, the number of perikymata between episodes of rLEH was determined from scanning electron micrographs of casts of the incisors and canines.

Both tooth formation and perikymata counts between episodes of rLEH indicate a clear semi-annual pattern. The apparent ubiquity of twice yearly stress in Asian and African apes is attributed to regular moisture cycles. Seasonal cycles can influence both disease and nutritional stress. Our current work is directed at seasonal cycles in intestinal parasites in apes. Research funded by Natural Sciences and Engineering Research Council of Canada (Individual Grant OGP0171168).

The morphological changes of intentional cranial deformation: examining the effects of ICD on paranasal sinus morphology. ST SLEMMER¹, S MARQUEZ², K MOWBRAY³, PJ GANNON⁴, and JT LAITMAN². ¹Univ Tennessee, Knoxville, TN 37996; ²Mount Sinai School of Medicine, NY, NY 10029, ³American Museum of Natural History, NY, NY 10024.

Previous craniofacial studies (Anton, 1989; Cheverud et al., 1992; Kohn et al., 1993) have revealed that the two basic types of intentional cranial deformation (ICD) – circumferential and fronto-occipital – generate specific changes in the shape of the chondrocranium (base), desmocranium (vault), and viscerocranium (face) to varying degrees. Naturally, the efficacy of ICD techniques depends on their application before brain growth cessation and the completion of cranial synostosis. Although the most evident morphological changes seen among ICD individuals occur in the skull vault, alterations do occur in the face and portions of the cranial base where all four paranasal sinuses initially develop. Accordingly, it is expected that the application of ICD procedures during the beginning stages of postnatal development should generate morphological changes in PNS anatomy.

Our study tests the hypothesis that ICD procedures initiate a cascade of developmental effects on the ontogeny of the PNS system. In order to address this issue, a cross sectional ontogenetic series of intentionally deformed (n=20) and non-deformed dry crania (n=40) from distinct Bolivian and Peruvian indigenous populations were selected from the Department of Anthropology at the American Museum of Natural History. The crania were CT scanned with a GE HiSpeed Advantage machine (150 kV, 140 mA). Volumetric determinations (e.g., maxillary sinus and endocranial volumes) and traditional craniofacial linear measurements (e.g., nasal breadth, height) were obtained, compared and assessed.

Preliminary results from CT film and 3-D reconstructed images of PNS morphology indicated that morphological differences between intentional and non-deformed crania were present primarily in the frontal region. The size and shape of the maxillary sinuses, however, appear to be unaffected. This study implies a highly conservative development, and independent growth trajectory, of the PNS. Our understanding of the factors that influence the complex dynamics of PNS development may be enhanced by analysis of these induced pathologies.

The geometry of landmarks aligned by generalized Procrustes analysis. D.E. SLICE, Ecology and Evolution, SUNY at Stony Brook, NY 11794.

Much of our understanding of the relatively new approach to shape analysis, geometric morphometrics, is due to work by Kendall on the geometric and statistical properties of shape

spaces defined by the Procrustes metric. One of Kendall's important results is that for p points in two dimensions, the shape space arising from the Procrustes metric is isometric to a complex projective space, CP^{p-2} , and, in the special case of triangles, is isometric to a 2-sphere of radius $1/4$.

Practical applications of geometric morphometrics, however, generally employ Generalized Procrustes Analysis (GPA) to superimpose samples of point configurations onto a reference (usually the sample mean) instead of the pair-wise optimization considered by Kendall. This procedure maps shapes not to Kendall's shape space, but onto a (hyper)hemisphere of radius 1.

Studies using real and simulated data show the hemisphere of GPA-aligned shapes is the preferred space from which to work when projecting samples into a linear tangent space for subsequent statistical analysis.

This poster outlines the geometric relationships between Kendall's shape space for triangles and the hemisphere of GPA superimposed landmark configurations. Examples are provided for triangles which allow accurate graphical depictions of the various shape spaces in 2 or 3 dimensions.

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Histological examination of apparent stages of healing an cribra orbitalia: A new method using silicone casting material. D. B. SMAY and G. J. ARMELAGOS. Emory University, Atlanta, Georgia 30322

The lesion commonly referred to in the paleopathological literature as cribra orbitalia exhibits a wide range of variation. These supraorbital plate lesions, which may be linked etiologically with the vault lesions of porotic hyperostosis, vary in expression between individuals from scattered porosity to extrusive, coral-like outgrowths of bone. An assumption is commonly made that these different expressions represent stages in healing and remodeling in the same pathology. Because cribra orbitalia is difficult to study in radiographic data sets, and because of the understandable reluctance of curators to allow their material to be damaged by thin sectioning, no satisfying histological examination has yet been undertaken to lend support to this assumption or to introduce doubt.

In this study, a sample of 8 individuals from Sudanese Nubia, which are representative of the different types of cribra orbitalia commonly found, was examined. Peels were prepared using dental quality silicone casting material

demonstrated to be accurate to 5000X. These peels were then examined under a scanning electron microscope and evaluated to determine whether the observed histology was consistent with the stages of healing hypothesis.

The results underscore the utility of this new method and the importance of microhistological examination in paleopathology. Both attribution of causal mechanism and populational significance can benefit from this approach.

A study of mtDNA of early Holocene North American skeletons. D.G. SMITH, R.S. MALHI, J.A. ESHLEMAN, and B.A. SCHULTZ, University of California, Davis, CA 95616.

DNA was twice extracted from 2-5 gram fragments of prehistoric skeletons previously discovered at widely dispersed geographic locations in North America. All of the skeletons have been dated to between about 8,000 and 11,000 years before the present and collectively represent the majority of the oldest known humans in the New World. Some of these skeletons have been shown to exhibit morphological traits that are uncharacteristic of modern Native Americans. Fragments of mitochondrial DNA (mtDNA) containing the diagnostic restriction sites that identify membership in the five mtDNA haplogroups to which all modern Native Americans belong were amplified from the first DNA extraction from each skeleton using the polymerase chain reaction (PCR) procedure.

Restriction analysis was then used to identify the presence or absence of these diagnostic restriction sites and each skeleton was provisionally assigned a haplogroup. These haplogroup assignments were confirmed by PCR amplifying and sequencing, using the second DNA extraction from each skeleton, an approximately 150 base pair fragment of the HVSI in the mtDNA control region that contains mutations characteristic of each of the five haplogroups. Monte Carlo simulation methods were used to test the null hypothesis that both the haplogroup distribution of and (within haplogroup) haplotype diversity among the ancient skeletons was randomly sampled from that of modern populations in the same, or nearby, geographic regions.

A NEW METHOD OF MEASURING 3-D INTERNAL DENTAL DIMENSIONS. EJ SMITH and SW SIMPSON. Department of Anatomy, Case Western Reserve University School of Medicine, Cleveland Ohio 44106

Numerous studies have described enamel thickness in extant and extinct taxa for the primary purposes of reconstructing diet and phylogeny. Most of these have relied either on naturally fractured teeth or prepared histological thin sections. Here, we present a novel

method of reconstructing in three dimensions the distribution of the dental tissues in teeth.

Serial sections of any object can be used to reconstruct the original 3-dimensional objects with the added benefit of illustrating all of the internal layers. This study presents preliminary results of the use of the SurfDriver (Moody and Lozanoff, 1999) program for the 3-D reconstruction of molar teeth focusing on the enamel, dentine and pulp cavity layers. Human upper right M2s from the La Florida archaeological sample are represented. Each tooth was serially ground by either 75 or 100 micron increments and imaged with a digital camera. Each tissue boundary in every section was manually traced from the image. The computer software builds and surfaces a 3-dimensional wireframe object. The resolution of the object is shown to be excellent limited only by the resolution of the camera and the thickness of each slice.

The resulting objects can be manipulated to allow a number of linear, angular, and volumetric measurements to be taken including enamel and dentine areas and volumes of the crown and individual cusps, enamel thicknesses in any direction around the tooth, and DEJ length. This allows for the comparison of morphology and determination of variation in enamel distribution within a tooth, across the dentition of one individual, within a taxon, or between taxa.

These data are especially useful for comparisons with naturally fractured and worn teeth. Fossil teeth are often fractured allowing both phylogenetic and functional information to be gleaned from the anatomy revealed within. The 'virtual' teeth can then be sectioned to provide the same views and measurements as the fortuitously fractured fossils.

High heels, halux valgus, Darwinian fitness, and sexual selection.
E.O. SMITH, Department of Anthropology, Emory University,
Atlanta, GA 30322.

High heeled shoes (HH) have a fascinating history from their origination in Greece with Aeschylus (525-456BC), to their spread through Western Europe beginning in the 14th century, to their arrival in North America in the mid 19th century. HH have assumed a variety of cultural interpretations as markers of high status and fashion, erotic accessories, as well as examples of the subjugation of women.

This paper takes an evolutionary perspective on wearing HH. From the wearer's perspective there are numerous costs and benefits that must be weighed in choosing to wear HH. Bunions, ankle fractures, lower back pain, shortened Achilles tendon, potential head trauma, increased energetic demands, reduced mobility, flattened arches, retrocalcaneal bursitis, and Haglund's deformity are among the physical costs associated with wearing HH. In addition, there are considerable economic costs associated with wearing HH. It is estimated that Americans spend approximately \$11 billion per year on HH.

Given these nontrivial costs, a strict Darwinian interpretation would suggest that wearing high heels is not a fitness enhancing trait. Certainly, there is no gene for wearing HH, but it is possible that wearing HH are part of a larger fitness enhancing set of evolved predispositions. An examination of the costs of wearing HH suggests that wearers cite enhanced appearance and postural changes as compensatory benefits for wearing HH. Wearers of HH enjoy enhanced sexual attractiveness to males

and in turn benefit from male competition and increased levels of female choice. If this is true then the advantages accruing to females from increased mate choice could outweigh short term physical and economic costs of wearing HH, particularly since only in the most extreme case could the costs be life threatening.

Histological analysis of shoulder and hip joints in lemurs, bats, and mice. T.D. SMITH, C.M. DION, A.M. BURROWS, School of Physical Therapy, Slippery Rock University, Slippery Rock, PA 16057, M.W. HAMRICK, Dept. Anthropology and Div. Biomed. Sci., Kent State Univ., Kent, OH 44242.

Numerous radiographic or gross anatomical studies have examined morphology of primate joints, but histological research on joint structure is rare. We examined the shoulder and hip joints from cadavers of *Microcebus murinus* (n= 7) for comparison with those of a bat (*Myotis myotis*, n=3) and a mouse (*Mus musculus*, n=2) in order to investigate micro-anatomical differences in articular cartilage (AC) and subchondral bone (SB) morphology related to interspecific differences in positional behavior.

In each specimen, the entire joint was dissected free, decalcified, embedded in paraffin wax, and sectioned at 10 µm (shoulder: parasagittal plane; hip: transverse plane). AC and SB thickness were examined qualitatively and the thickness ratio of AC/SB was quantified using a Leica DMLB photomicroscope with a stage micrometer.

In the quadrupedal species, the AC appeared to be relatively thickest in the femur compared to that of the humerus. In contrast, the AC of the bat femur was relatively thin or equal compared to that of the humerus. In all species, AC was thickest in the acetabulum and the SB was thickest in the lemur acetabulum. For all species, preliminary quantitative results suggested that AC/SB ratios were lower in the humerus compared to the glenoid and lower in the acetabulum compared to the femur. The quadrupedal species had lower AC/SB ratios in the humerus and acetabulum compared to the bat; the lowest ratio was observed in the lemur acetabulum. In lemurs this appeared to reflect proportionally thicker SB in the acetabulum. The results suggest that habitual use of the hindlimbs in suspensory postures by *Myotis* is associated with differences in epiphyseal histology compared to more quadrupedal mammals. The findings also support previous studies that suggest the subchondral plate thickness of the acetabulum is associated with compressive, weight-bearing forces.

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A re-evaluation of enamel thickness and development in *Afropithecus turkanensis*. T.M. SMITH and L.B. MARTIN; Anthropological Sciences; S.U.N.Y. at Stony Brook; Stony Brook, NY 11794.

A. turkanensis is an early Miocene hominoid known from sites in Kenya dated to 17-18 m.y.a. It had previously

been described as having very thick, fast formed enamel (Martin, 1995). In the reported condition of "very thick" enamel, *A. turkanensis* appeared to differ from other early and middle Miocene apes and to show similarities to *Graecopithecus freybergi* and *Paranthropus*. This study focused on quantifying enamel thickness, and examining enamel microstructure and development in this early Miocene ape in comparison with *G. freybergi* and *Paranthropus*. Recent studies of enamel in *Proconsul* provide a basis for comparison with a contemporaneous Miocene hominoid (Beynon *et al.*, 1998).

Two previously prepared teeth were examined using Scanning Electron Microscopy (SEM) and Polarized Light Microscopy (PLM). Enamel thickness was measured following established procedures. Measurements of cross-striation repeat intervals and counts of cross-striations between Retzius lines were made where possible using both SEM and PLM. Angles of intersection were measured between the striae of Retzius and the enamel dentine junction in the cervical and lateral enamel on both teeth.

The results of this study show that Martin (1995) miscalculated relative enamel thickness for *A. turkanensis*, which does not have the extremely thick enamel seen in *G. freybergi* or *Paranthropus*. Rather, *A. turkanensis* has enamel of a thickness comparable to the Paşalar hominoids or *Sivapithecus*, which have been characterized as having "thick enamel". *A. turkanensis* has thicker enamel than *Proconsul africanus* and *Proconsul major*, but does not differ much from what has been reported for *Proconsul nyanzae* and *Proconsul heseloni* (Beynon *et al.*, 1998). An examination of enamel microstructure shows a pattern of development similar to that reported for *P. heseloni* and *P. nyanzae* in terms of cross-striation repeat intervals and the periodicity of Retzius lines. These findings suggest that the enamel of *A. turkanensis* is not as distinct from other early and middle Miocene hominoids, including *Heliopithecus*, as had been previously argued.

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Prosimian hypometabolism revisited: The influence of body composition. J.J. SNODGRASS, W.R. LEONARD, and M.L. ROBERTSON. Northwestern University, Evanston, IL 60208.

Prosimians differ from other primates in having depressed metabolic rates. That is, prosimians tend to have resting metabolic rates (RMRs) lower than those predicted for their size based on the Kleiber scaling relationship. While a number of explanations have been offered for hypometabolism in prosimians (e.g., phylogenetic inertia, dietary stress), the phenomenon has not been systematically studied. Thus, the purpose of this paper is to examine differences in RMR between prosimians and anthropoids, and to evaluate alternative explanations for those differences.

Data on body mass (kg) and RMR (kcal/d) were obtained for 17 prosimian and 23 anthropoid species. Metabolic rates in the prosimians average (\pm SE) $38.6 \pm 4.7\%$ below that predicted by the Kleiber

relationship, whereas anthropoids are $3.5\% \pm 3.6\%$ above predicted values. Additionally, the scaling relationship between RMR and body mass significantly differs between the two groups. For anthropoids the relationship is: $RMR = 68.7(Wt)^{0.78}$, which is almost identical to the Kleiber relationship (i.e., $RMR = 70[Wt]^{0.75}$). In contrast, the relationship in the prosimians is: $RMR = 36.3(Wt)^{0.56}$.

The differences in metabolism between prosimians and anthropoids appear to be partly attributable to differences in body composition. Given that there are large differences in mass-specific metabolic rate among tissues, differences in the mass of these tissues can greatly shape total metabolic costs. Prosimians are less encephalized than anthropoids. Additionally, prosimians also appear to have lower levels of skeletal muscle mass than anthropoid species. Some of the differences in muscularity and metabolic intensity reflect differences in locomotor patterns or habitat use, as arboreal species have lower metabolic rates than terrestrial species (deviation from predicted = $-22.1 \pm 4.6\%$ vs. $+3.8 \pm 8.6\%$; $P = 0.017$). However, even after controlling for dominant habitat, arboreal prosimians have lower metabolic rates than arboreal anthropoids (deviation = $-36.6 \pm 4.6\%$ vs. $-2.7 \pm 4.9\%$; $P < 0.001$).

Cancer incidences in Europe related to ethnohistoric and genetic distances. R.R. SOKAL, N.L. ODEN, M.S. ROSENBERG, and B.A. THOMSON, Ecology and Evolution, SUNY at Stony Brook, NY 11794-5245.

We have previously shown that geographic differences in cancer mortalities in Europe are related to (in order of importance): geographic distances (reflecting environmental differences), ethnohistoric distances (encompassing cultural and genetic attributes), and genetic distances of the populations in the areas studied. In this study, we analyzed the same three factors in geographic differences for European incidences of up to 45 cancers for each sex. Differences in cancer incidences are correlated moderately, first with geographic distances, then with genetic distances, but not at all with ethnohistoric distances.

Comparing these findings to the earlier ones for cancer mortalities, we note the reversal in the importance of ethnohistory and genetics between the two cancer rates, and the generally lower correlations of incidence differences with the three putatively causal distance matrices. A path diagram combining the two studies demonstrates the lack of cultural carcinogenic effects, but suggests cultural influences on procedures such as the registration of deaths in different political entities. In addition to these cultural differences, the relatively large correlation between ethnohistoric distances and mortality differences is due to common factors behind the correlation of ethnohistoric and geographic distances. Geographic proximity results in similar ethnohistories. The direct effects of genetic distances are negligible and only their common effects with geographic distances play a role, accounting for the weak to

negligible influence of genetics on incidence and mortality differences. Apparently, the genetic systems available to us do not substantially affect cancer incidence or mortality.

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Identification of cystic lesions in prehistoric skeletal remains from New York State. M.C. SOLANO and C.N. AYOTT, Department of Anthropology, University at Albany, State University of New York.

Paleopathological diagnoses are useful for assessing health and diseases in human skeletal populations, although difficulties lie in creating associations between paleopathological conditions and modern clinical descriptions of disease. Systematic analysis of skeletal collections from the New York State Museum has resulted in the discovery of a specific, tumor-like lesions in five individuals. The lesions, however, are not clearly identifiable from either the paleopathological or medical literature.

The five skeletons (4 male, 1 female) come from four prehistoric Native American sites from New York State, dating between the Late Archaic (3100 B.C.) and Late Woodland (1300 A.D.) periods. The lesions are characterized as small (<1 cm), round or ovoid depressions on the periosteal surface of the bone, fine granularity of internal surface, sharp margins, and mild or no activity of the surrounding bone. Four of the five individuals possess lesions in the orbits and/or on the frontal, while one lesion is present on a tibial diaphysis.

Based on the medical literature, the lesions can be best identified as circumscribed osteoma (or osteoid osteoma), although the clinical manifestations are difficult to compare to dry bone. While the paleopathological literature contains many examples of tumor-like lesions, descriptions and documentation of these pathologies are largely insufficient for identifying them in other skeletal analyses. Nevertheless, both medical and paleopathological data are combined in order to make a differential diagnosis of this neoplastic condition.

Reproductive strategies and paternity in wild Japanese macaques on Yakushima Island, Japan. J. SOLTIS¹, R. THOMSEN², and O. TAKENAKA³.

¹Department of Anthropology, University of California, Los Angeles, CA 90095, USA.

²Department of Zoology, University of Munich, Germany. ³Department of Cellular and Molecular Biology, Kyoto University, Japan.

Paternity discrimination by analyzing subject DNA is critical to the study of animal reproductive strategies.

Among primates, however, most paternity studies to date have occurred in captive or provisioned groups. Here we report the first paternity study of Japanese macaques (*Macaca fuscata yakui*) living in natural habitats. Behavioral observations were conducted for one mating season, and subject DNA was recovered from samples collected non-invasively in the field (feces, urine, ejaculate). To amplify micro-satellite loci, we used nine primers known to be polymorphic in the study population.

Paternity was determined for nine of ten offspring born the following birth season. Three of the nine offspring (33%) were sired by non-troop males. The remaining six offspring (67%) were most likely sired by troop males, and high ranking males were more likely to sire these offspring than low ranking males ($r_s=0.587$, $n=15$ males, $p<0.05$). Observed mating success was also positively correlated with male dominance rank ($r_s=0.700$, $n=15$ males, $p<0.001$). Low ranking males were the most likely to engage in sneak copulations (i.e. to mate outside the presence of other males; $r_s=-0.783$, $n=15$ males, $p<0.001$). The mean number of females exhibiting mating behavior per day was 2.44 (range: 1-5). These females attempted to mate with multiple males of variable dominance ranks, including both high and low ranking males. Although females and mid to low ranking males sometimes mated, and a few mid-ranking males sired offspring, high ranking males were able to monopolize most female matings as well as paternity.

Temporal patterning of enamel hypoplasias: a study from the Larson site (39WW2), Walworth county, South Dakota. C.S. SPARKS, Department of Anthropology, University of Tennessee, Knoxville, Tennessee 37996

Enamel hypoplasias have been identified as an excellent record of nutritional and metabolic stress in human populations. The Post-Contact Arikara population from the Upper Missouri River valley is a group not yet studied for these defects. The possible etiological and temporal significance of defects in the Arikara sample are key in reconstructing the earth-lodge village lifeway exhibited at the Larson Site.

The Arikara skeletal series from the Larson site (39WW2) was examined on an intrasite basis in order to detect any temporal trends in the prevalence and age of formation of enamel hypoplasias. A total of 220 adult individuals was examined for presence and age of formation of hypoplastic episodes. The mean ages were calculated for the four temporal features identified by field notes and separated temporally by differential presence of European trade goods associated with the burials. Statistical comparisons of the four features were conducted by means of the Dunnett T-3 ANOVA test. This test yielded significant difference in mean age of defect formation between cemetery and village areas. The difference in mean ages reflects a trend, which shows an increase in age of formation, and an increase in prevalence from the earlier features to an apex at the terminal occupation.

This trend is interpreted to constitute a temporal shift in disease etiology from weaning diarrhea during the earlier occupations of the site to more stress from parasitic disease loads during the terminal village phase. The parasitic disease hypothesis is further substantiated by a high prevalence of porotic hyperostosis in the village sample. The crowded, unsanitary conditions of the earth-lodge village would provide a deleterious environment for the village people on the eve of the 1734 smallpox outbreak among the Arikara, which in conjunction with pressing hostilities from neighboring tribes culminated in the destruction and abandonment of the site soon after.

Muscle function and temporomandibular joint loading in baboons: continuous visualization of *in vivo* electromyographic data. M.A. SPENCER, Department of Anthropology, University of Colorado, Denver, CO 80217, and W.L. HYLANDER, Duke University Medical Center, Durham, NC 27710.

Although the forces experienced in the temporomandibular joint (TMJ) of primates are poorly understood, the nature of these forces must have a strong influence on both the function and evolution of the masticatory system. Most authors agree that the mandibular condyles are typically pushed against the articular eminence during routine mastication. Additionally, subcondylar bone strain experiments in the macaque suggest that the working-side condyle may be intermittently pulled away from the eminence during third molar biting. The purpose of this study is to explore patterns of muscle recruitment and inferred joint loads during normal mastication in the baboon.

Temporomandibular joint reaction forces are determined by the forces applied to the mandible by the masticatory muscles and the location of the bite point. Since forces vary considerably among these muscles throughout the chewing cycle, we chose to examine continuous muscle function, and to explore the influence of changes in muscle activity on joint reaction forces. Electromyographic data recorded simultaneously from four homologous pairs of masticatory muscles (superficial and deep masseter, and anterior and posterior temporalis muscles) were 'streamed' through a custom computer program. This program calculates the ratio of working- to balancing-side activity for each muscle pair, and displays the position of the muscle resultant forces for these pairs overlaid on an image of a baboon mandible. Muscle resultant positions are updated every 2ms throughout the chewing cycle. An average muscle resultant position for all muscles is also calculated every 2ms and used to estimate the forces at the working- and balancing-side TMJs.

The analysis indicates that there are substantial changes in working/balancing side activity in all muscle pairs during normal mastication. Despite these changes, the movement of the average muscle resultant force is strongly patterned. While muscle resultant force position is erratic at the very beginning and end of each power stroke (when forces are low), it is typically stable in position and located toward the working side during most of the power stroke (when muscle forces are high). Estimated joint reaction forces suggest that the working side TMJ is occasionally pulled away from the articular eminence very weakly at the beginning or end of the power stroke. However, during most of the power stroke the working- and balancing-side condyles are pushed against the articular eminence with nearly equal force.

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Basicranial architecture of Plio-Pleistocene hominins. F. SPOOR, Department of Anatomy and Developmental Biology, University College London, WC1E 6JJ, U.K.

One of the principle morphological features that distinguishes *Homo sapiens* from other primates is the major reorganization of its cranial base. The human basioccipital has a more inclined orientation relative to the anterior cranial base, shown as a high degree of midline basicranial flexion, and the foramen magnum faces more inferiorly. The petrous pyramids are more coronally oriented and, like the basioccipital, their posterior surface is more inclined relative to the orientation of the anterior cranial base. The cranial base forms the floor on which the brain rests and it articulates with the spine as well as with the face. Hence, its unique morphology in humans may be associated with aspects of all three key processes of human evolution: encephalization, the change to obligatory bipedalism and a reduction of the masticatory apparatus.

To further investigate these relationships the basicranial architecture of 19 African and Asian Plio-Pleistocene hominins was studied, using CT to visualize their endocranial morphology. Angles describing the orientation of the anterior cranial base, the basioccipital, the foramen magnum and the posterior petrosal surfaces were taken from scans made in sagittal and transverse planes.

Results demonstrate that the evolutionary history of the hominin cranial base can not be described as a single trend towards a more modern human-like morphology. Rather, it appears that different aspects change with a considerable degree of independence, following different patterns in each species. For example, whereas the petrous pyramid and foramen magnum orientations in *Homo ergaster* are more modern human-like, its midline basicranial flexion is similar to that seen in great apes. Thus, a more inferiorly facing foramen magnum predates, and not simply follows from a highly flexed cranial base. *Australopithecus boisei* shows a different pattern in that most aspects, including basicranial flexion, are modern human-like, but this species does not show the coronally oriented petrous pyramids. These comparative observations will be discussed in relation to brain development, body posture and facial morphology.

Lifetime likelihood of becoming an alpha male for Japanese macaque males. D. S. SPRAGUE, Nat. Inst. of Agro-Environmental Sciences, Tsukuba 305-8604, Japan, and S. SUZUKI, Lab. of Human Evolution Studies, Faculty of Science, Kyoto University, Kyoto 606-8502, Japan.

What is the likelihood that a male Japanese macaque (*Macaca fuscata*) becomes an alpha male in a troop during its lifetime? Based on a sociodemographic model of male

dominance rank, we estimated the proportion of males that become an alpha male in a multi-male Japanese macaque troop under reasonable demographic conditions. The factors in the model are (a) age-graded dominance rank, (b) age specific survival, (c) length of alpha male tenure, and (d) troop size.

The model assumes that alpha males tend to be prime adult males. Better survival may not lead to a greater likelihood of becoming an alpha male because better survival increases the pool of adult males competing for higher rank. More prime adult males may have the opportunity to become alpha males under the following conditions. The pool of potential alpha males is reduced by lower survival to adulthood and a narrower alpha male age window. Shorter alpha male tenure gives more males a turn to become an alpha male. Smaller troops divide the population into more troops, creating more alpha male positions in a population. Using applicable field data on troop demography and male troop tenure from the Yakushima study site, the model predicts that many adult males probably do not become alpha males even in a population with relatively small troops and constant alpha male turnover.

Ecological correlates of diurnal variation in gonadal and adrenal activity in rural Bolivian Aymara men. J.F. STALLINGS, Emory University, Atlanta, GA, 30322, V.J. VITZTHUM, SUNY Binghamton, NY, 13901, C.M. WORTHMAN, Emory University, Atlanta, GA, 30322.

Diurnal patterns of the principal hormones of the hypothalamo-pituitary-gonadal (HPG) and -adrenal (HPA) axes, testosterone (T) and cortisol (C), have long been considered as characteristic regulatory features associated with declines in both of these hormones across the day. Such diurnal patterns are known to reflect central processes and are considered intrinsic to chronobiology. Yet increasing evidence has emerged for the impact of numerous ecological variables (behavior, energetics, altitude, psychosocial dynamics) on both the HPA and HPG axes. Ecological factors have been found to exert acute as well as long-term effects on both T and C circulating levels and responsiveness to challenge. This report concerns an investigation of the relationship between diurnal patterns of C and T and ecological stressors (high altitude, workload, social and nutritional status) in a sample of 65 rural Bolivian Aymara men ages 21-60 years, each sampled at AM and PM every other day for 6 consecutive days. The HPA and HPG axes are usually studied separately, but they are here studied in tandem, in an effort to tease out the factors that exert concordant versus discordant effects on each axis.

Contrary to the expected diurnal pattern of a 40-50% morning-evening decline in C and T, we observed that within individuals, PM C and T each exhibited an equal

probability of being higher or lower than AM values. Moreover, PM values were uncorrelated with AM values for either hormone. Despite this intra-individual dissociation of evening from morning endocrine activity and a lack of correlation between AM C and T ($r = .165$, $p = .28$), PM values of C and T were correlated ($r = .359$, $p < .02$). Individuals with higher AM than PM cortisol were also more likely to exhibit greater AM than PM T, and the converse ($p < .01$). These findings suggest that ecological-behavioral influences responsible for elevated PM values act on both axes, and contravene the negative relationship of C and T usually associated with psychological and physical stress. It is however consonant with the effects of mild-moderate exercise, although at altitude any exacerbation of hypoxic stress by exercise would be expected to antagonize testicular release of T. These results will be further probed by considering the potential impact of nutritional status (BMI, dietary intake, hemoglobin), social status (education, income), activity (occupation), and age as moderators of daily activity of both the HPA and HPG axes. Data from REPA; NSF: SBR 9506107 to V.J. Vitzthum.

Ecology of chimpanzees in Bwindi-Impenetrable National Park, Uganda; preliminary results. C.B. STANFORD, Department of Anthropology, University of Southern California, Los Angeles, CA 90089-0032; M.A. KEIVER, International Gorilla Conservation Programme, Kabale, Uganda.

Wild chimpanzees (*Pan troglodytes schweinfurthii*) in Bwindi-Impenetrable National Park, Uganda, occur in sympatry with the park's population of mountain gorillas (*Gorilla gorilla beringei*). This paper reports on the preliminary results of field research from 1997-1999 on a population of chimpanzees (roughly estimated to be 350-400 individuals) and their ecological relationship with gorillas in Bwindi. Within the study area, chimpanzee nests were mapped and diet data were collected from dung and by limited direct observation. Data on more than 500 nests showed that nest tree species choice did not show a significantly positive correlation with food tree species choice. Nesting most often occurred in close proximity to, but not in, food trees used just before the time of nesting. Chimpanzee nest height showed a significant positive correlation with both tree height and elevation above sea level. Bwindi gorillas, by contrast, typically nested on the ground, but about 10% of gorilla nests were found from 0.5 - 4 m above the forest floor. Gorillas in Bwindi tend to nest in trees more often than gorillas in the Virungas do, but at a significantly lower height and in a lower diversity of nesting tree species than Bwindi chimpanzees use.

Chimpanzee party size in Bwindi varied from 1 to at least 17 during the study period. Chimpanzee diet showed strong convergence with gorilla diet during periods of peak fruit availability. During the dry season months of July-August 1997 and 1998, both species fed primarily on only three species of fruit (*Chrysophyllum gorungosanum* [Sapotaceae], *Cassia aethiopica* [Celastraceae], and *Syzgium guineense* [Myrtaceae]).

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Biocultural synthesis of multiple disease processes in 19th century Dunning Poorhouse inmates. D. W. STEADMAN, Department of Anthropology, Iowa State University, Ames, Iowa.

The analysis of skeletal pathology in the 19th century Dunning Poorhouse Cemetery sample in Chicago significantly contributes to our understanding of health among historic urban Americans and immigrant populations. Skeletal biologists have traditionally focused on single disease processes to explain whole suites of pathological lesions. However, the analysis of historical documents can shed light on the environmental, cultural and social factors that affected population health and better equips us to examine multiple, concurrent disease patterns within individuals and populations. While a comprehensive analysis of the demography and health of the Dunning sample is forthcoming, the complex pathology of one individual illustrates the importance of considering multifactorial disease processes.

Burial 19, an elderly adult male, suffered from extensive osteoarthritic changes in nearly every joint of the body, ankylosis of C2-C4, spondylolysis and compression fracture of L4, and bilateral hip dysplasia that severely limited joint mobility. Differential diagnosis involves the evaluation of localized and systemic diseases as well as single and multiple traumatic events. Historical records indicate that daily life was extremely difficult and poorhouse inmates were expected to work for their food and shelter. The analysis of the Dunning skeletal sample found a high incidence of chronic occupational stress markers, particularly on the back and shoulder regions, and little evidence of chronic infectious disease despite the prevalence of pulmonary tuberculosis at the time. High frequencies of fractures, enthesopathy, Schmorl's nodes and other vertebral pathologies are common in both sexes at Dunning, which is consistent with long-term manual labor. Within this biocultural context, the results of the analysis indicate that multiple traumatic episodes as well as habitual stress contributed to the complex disease pattern observed in Burial 19. This case is not wholly unique for Dunning since many other individuals exhibited complex pathological conditions that were exasperated by heavy physical activity.

A Geographic Information System analysis of variation in health and nutrition in the Western Hemisphere. R. H. STECKEL, Department of Economics, Ohio State University, Columbus, OH 43210, P. L. WALKER and N. M. CRAIG, Department of Anthropology, University of California, Santa Barbara, CA 93106

The Health and Nutrition in the Western Hemisphere database provides a unique opportunity to explore the social, economic, and environmental determinants of variation in the health and nutrition of New World populations. This database contains observations of age, sex, skeletal dimensions, and pathological conditions, made on the remains of more than 12,500 individuals of Native American (n=9826), Euro-American (n=1304),

and African-American (n=1380) ancestry. These people lived at more than 200 sites in North, Central, and South America from about 4000 B.C. to the early 20th century.

A series of research teams assembled this database using standardized recording techniques that allow direct comparisons to be made of conditions such as dental hypoplasia, porotic hyperostosis, non-specific infections, and traumatic injuries. To obtain summary health indices, these observations were weighted based the number of years an individual's health would have been affected by a condition using model life tables.

The relationship between health status and local environmental conditions was explored using Geographic Information System databases containing site-specific information on topographical relief, precipitation, and seasonal variation in primary productivity. Multiple regression analysis reveals that more than 40% of the variance in the summary health index can be accounted for by a model that includes information on site elevation, cultigen use, and measures of seasonal variation in green-leaf biomass (the normalized differential vegetation index) obtained from remote sensing satellites. These results suggest that Geographic Information System analysis of data from large-scale bioarchaeological surveys has great potential as a tool for elucidating the causes of variation in the health of human populations.

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Marquesan Intra-archipelago Cranial Variation. V.H. STEFAN, University of New Mexico, Albuquerque, NM 87131, and P.M. CHAPMAN, South Puget Sound Community College, Olympia, WA 98512

The Marquesas Archipelago has traditionally been divided into a northern and a southern group. The northern group includes the islands of Nukuhiva, Uahuka, and Uapou, and the southern group includes Hivaoa, Tahuata and Fatuhiva. The Marquesan language has been divided into two dialects which correspond with this archipelago division (Green, 1966), and has been supported by the work of Lavondès & Randall (1978) which found that the languages of the southern islands were more closely related to each other than either was to the northern islands. Ethnohistoric voyaging records indicated that there were northern and southern interaction zones but only the occasional voyage between. This study examines Marquesan cranial discrete and metric traits to evaluate the level of intra-archipelago heterogeneity and to determine if a northern/southern division is evident crani-ally.

The data consist of 28 cranial discrete traits and 50 cranio-facial measurements of prehistoric Marquesans. Male and female data were pooled for the discrete trait and for metric data following a Darrock & Mossiman size adjustment. The data consisted of three island samples: Nukahiva (north), Fatuhiva (south), and a combined Hivaoa/Tahuata (south). Of the 28 discrete traits, 16 were utilized in a Mean Measure of Divergence analysis that provided scores of 0.259 for

Fatuhiva-Hivaoa/Tahuata, 1.850 for Nukahiva-Fatuhiva, and 1.491 for Nukahiva-Hivaoa/Tahuata. ANOVA statistical analyses revealed 10 metric variables for males and 1 for females that were significant between islands. RMET analysis utilizing those variables provided unbiased D^2 values of 0.014 for Fatuhiva-Hivaoa/Tahuata, 0.111 for Nukahiva-Fatuhiva, and 0.079 for Nukahiva-Hivaoa/Tahuata. The islands of the southern group were closer to each other than either was to the island of the northern group.

These results indicate that there were cranial discrete trait and metric differences between the islands of the northern and southern Marquesas islands, supporting the findings of previous research that documented the linguistic and cultural differences between those regions of the archipelago.

Heritability of cross-sectional morphology in long bones of anthropoid primates. T.A. STEIN, Department of Anthropology, The University of Chicago, Chicago, IL 60637.

The relationship between the mechanical conditions to which bone tissue is exposed and the remodeling processes that control bone shape is undisputed. Numerous studies have shown that the geometric morphology of long bone diaphyses is achieved, at least partially, through adaptive remodeling in response to forces encountered during normal activity (e.g., Biewener, 1990; Biewener and Bertram, 1994; Lanyon, 1980; 1982; 1987; Ruff, 1985; 1987a; 1989; 1990). Because of the adaptive characteristic of bone, the cross-sectional morphology of long bone diaphyses has been used to infer behavior in humans (Brock and Ruff, 1988; Ruff 1987b; Ruff and Hayes, 1983a; 1983b; Ruff et al., 1999), as well as basic locomotor characteristics in nonhuman primates (Demes and Jungers, 1993; Demes et al., 1991). Although there seems to be no question regarding the ability of bone tissue to adaptively remodel in response to mechanical stress, little is known regarding the degree to which developmental, genetic, phylogenetic, etc. factors affect diaphyseal shape.

This study tests the heritability of cross-sectional morphology of long bone diaphyses in anthropoid primates. Mother-offspring pairs of *Macaca mulatta* from the Caribbean Primate Research Center at the University of Puerto Rico were used. A CT scanner was used to obtain cross-sectional images at five points along the diaphysis of all long bones, except the fibula, of each individual. Image analysis software was used to calculate appropriate cross-sectional geometric properties (e.g., areas, second moments of area, polar moment of area, angle alpha). And the heritability was analyzed using the methodology described by Cheverud (1982).

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Taxonomic affinity of a new specimen from Cooper's, South Africa. C. M. STEININGER and L. R. BERGER, Unit for Research and Exploration in Palaeo-anthropology, Dept. of Anatomical Sciences and Dept. of Palaeontology, University of the Witwatersrand, Johannesburg 2193, South Africa

A new hominid specimen from the Plio-Pleistocene cave site of Cooper's has been discovered in the collections of the Transvaal Museum. This brings the total number of individuals from this site to three. Earlier finds include an upper left third molar and an upper right central incisor (COA-1). The upper left molar has been attributed to *Australopithecus africanus*, while the taxonomic affinity for COA-1 is *Homo sp. indet.*

During a brief period in 1954 C.K. Brain collected *in situ* and miner's dump material from Cooper's. The material was brought back and prepared, but was believed not to contain hominids. The fossils were accessioned and stored, but upon recent sorting a facial skeleton (COB 101) was found by one of the authors (CMS).

This partial right facial skeleton consists of the maxilla including subnasal and alveolar regions with a right upper third premolar and the disarticulated supraorbital torus attached to the maxilla by matrix.

On preliminary analysis, features found on COB 101 are consistent with the taxonomic affinity of *Australopithecus robustus*. Thus, indicating a fifth robust australopithecine site in South Africa.

Recent excavations do not clearly indicate multiple depositional events at the main fossil bearing locality at Cooper's, therefore it raises the possibility that several distinct taxa are represented within this assemblage.

Effects of substrate size and orientation on quadrupedal walking in *Cheirogaleus*. N.J. STEVENS, Doctoral Program in Anthropological Science, SUNY @ Stony Brook, Stony Brook NY 11794.

The arboreal environment presents a number of challenges for quadrupedal locomotion (Grand 1979). Two of the most obvious are that branches vary in diameter and orientation. Substrate size affects an animal's mediolateral balance (e.g. Schmitt 1995), while substrate orientation affects an animal's anteroposterior balance. As an arboreal radiation of mammals, primates have had to develop mechanisms to meet these challenges. This study examines postural accommodations to changes in substrate size and orientation in *Cheirogaleus*.

Cheirogaleids are unique in that they have the shortest relative limb lengths of all prosimians (Jungers 1985), and a number of researchers have likened their postcranial morphology to the ancestral primate condition (Cartmill 1972; Gebo 1987, 1989; Fleagle 1988). Thus, *Cheirogaleus* serves as an interesting taxon for comparison, both with more derived primates (Stevens, in prep.), and with other mammalian taxa (Schmitt and Lemelin, in prep.).

Limb posture was recorded during locomotion on branches of two different diameters and orientations. Joint angles were measured at touchdown, midstance, and toe-off, and angular excursions were calculated. In addition, stride lengths and gait patterns were examined.

Among the adjustments to substrate size were higher shoulder and elbow joint angles on larger supports, and higher hip and knee joint angles on smaller supports. Both fore- and hind limbs underwent larger angular excursions on smaller supports.

This asymmetry between fore- and hind limb postural adjustments was also seen in response to substrate orientation. Relative to the horizontal, shoulder and elbow joint angles are lower on inclines and higher on declines, while hip and knee joint angles are higher on inclines and lower on declines. Both fore- and the hind limbs displayed larger angular excursions on inclines than on horizontal supports.

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Sex, hormones, biosocial context, and attention deficit hyperactivity (ADHD) disorder. J.C. STEVENSON¹ and D.C. WILLIAMS², Departments of Anthropology¹ and Biology², Western Washington University, Bellingham, WA 98225.

One of the most striking aspects of ADHD is the uneven sex ratio with significantly more affected males than females, 2:1 to 10:1 ratios, in epidemiological versus clinical samples. Comorbidity patterns also differ. Suggested explanations include differences in: referral rates, diagnostic thresholds, and socialization patterns. These explanations are not mutually exclusive, and we argue that sex differences in expression of ADHD are a result of evolved biosocial differences, especially in communication skills and the ability to self inhibit.

Dissimilarities in the expression of attentional disorders and the associated comorbidity patterns are consistent with the underlying anatomical, physiological and behavioral differences between males and females, and between controls and affected individuals. Male ADHD's are more likely to be hyperactive and aggressive and females inattentive, anxious and depressed. There is sexual dimorphism in the prefrontal-striatal-thalamo-cortical circuitry as well as how ADHD affects this circuitry. Different structures are smaller or less physiologically active depending on sex. Most of these structures are influenced by hormonal milieu. Estradiol levels and the numbers of target receptors differ between males and females and influence both the dopaminergic and serotonergic systems. The dopamine system is implicated in ADHD but can interact with the serotonin pathway. Serotonin may be a factor in some of the comorbid behaviors such as aggression and depression. Finally, socialization and developmental differences mediate how an individual expresses this disorder and in the case of females, may be overlooked in girls (because they are not usually hyperactive) and misdiagnosed as depression in women.

Genetic differences between humans and chimpanzees: above and beyond the silent substitution rate. C.-B. STEWART, Biological Sciences, University at Albany, SUNY, Albany, NY 12222. E-mail: c.stewart@albany.edu.

It is often stated that the nuclear DNAs of humans and chimpanzees only differ by approximately 1.5%. A widely-held assumption appears to be that a small subset of these genetic differences underlie the vast morphological and behavioral divergence between these species. It should be remembered, however, that this number has been estimated using nucleotide differences (length and point mutations) between aligned orthologous segments of DNA, and predominantly represents the 'silent' or neutral mutation rate. Thus, this 1.5% genetic difference does not include larger mutational events (such as gene duplications, rearrangements, or retroelement insertions) that may have large organismal effects.

Indeed, humans are known to have thousands of recent Alu retroelement insertions that are not found in chimpanzees or other hominoids. We have found that the Alu source genes contain putative binding sites for numerous transcription factors. Thus, the recent Alu insertions could change the regulation of key genes.

Moreover, genes can evolve much faster than the neutral rate if they are under positive selection. We have identified some protein-coding genes that have evolved under positive selection between humans and chimpanzees. Two of them code for the sperm-specific protamines, P1 and P2, which replace DNA-binding proteins during spermatogenesis. With the exception of humans, all mammals studied bind 100% of mature sperm DNA by protamines; other primates have yet to be studied. In humans, 15% of sperm DNA remains bound by histones in a sequence-specific manner, leaving it accessible to DNA-modifying enzymes. We hypothesize that P2 binds preferentially to CpG dinucleotides, which are abundant in Alu elements, and that this protamine-Alu interaction helps create the unique chromatin structure of human sperm DNA. If so, recent Alu insertions could cause different genes to be methylated in chimpanzees versus humans, perhaps influencing imprinting or gene expression during early development. Experiments are in progress to begin to test these hypotheses.

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Paleolithic population growth pulses evidenced by small animal exploitation. M. C. STINER, N. D. MUNRO, and T. A. SUROVELL. Dept. of Anthropology, University of Arizona, Tucson, AZ 85721.

Variations in small game hunting along the northern and eastern rims of the Mediterranean Sea and results from predator-prey simulation modeling indicate that human population densities increased abruptly during the late Middle Paleolithic and again during the Upper and Epi-Paleolithic periods. The demographic pulses are evidenced by increasing reliance on agile, fast-reproducing partridges, hares and rabbits at the expense of slow-reproducing but easily caught

tortoises and marine shellfish and, concurrently, climate-independent size diminution in the tortoises and shellfish. The results indicate that human populations of the early Middle Paleolithic were exceptionally small and highly dispersed.

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Behavioral implications of long bone morphology among southern African and Andamanese foragers.

J. STOCK, Department of Anthropology, University of Toronto, Toronto, Ontario, Canada, M5S 3G3.

Cross-sectional properties of cortical bone distribution in long bone diaphyses are responsive to mechanical loading, and therefore reflective of functional requirements during life. This supports the use of cross-sectional properties to interpret behavioral patterns and intensity from skeletal structure. Behavioral interpretations of prehistoric human remains are often dependent upon our ability to distinguish patterns of habitual foraging activities from skeletal structure.

This study compares cross-sectional properties of two groups of hunter-gatherers to determine if diaphyseal structure is sufficiently plastic to reflect variations in subsistence behavior. The samples used for this comparison belong to the southern African Later Stone Age (LSA; $n=65$, $\sigma=33$, $\varphi=28$) dating from ca. 10,000 to 2,000 B.P., and the indigenous Andaman Islanders of the 19th century (AI; $n=36$, $\sigma=17$, $\varphi=16$). The LSA and AI both relied on a combination of marine and terrestrial resources, and share broad similarities in body size and limb proportions which facilitate morphological comparisons. Cross-sectional properties were calculated at the cnemic foramen of the tibia and the diaphyseal midshafts of the clavicle, humerus, femur and first metatarsal, providing a representation of robustness throughout the body.

After cross-sectional properties are appropriately scaled to body size, the results of multivariate ANOVA illustrate that the AI have significantly stronger clavicles and humeri than the LSA. In contrast, the LSA femora, tibiae and first metatarsals are significantly stronger than those of the AI. This morphological variability can be interpreted in relation to differences between the AI and LSA in the methods of exploitation of marine resources and the intensity of terrestrial locomotion. The strength of the upper body among the AI is likely representative of the increased importance of offshore marine resources, while the contrasting lower body strength among the LSA suggests that their subsistence economy was dependent upon greater terrestrial mobility.

A matrix correlation model for investigating aspects of prehistoric intracemetery variation and population subdivision. C.M. STOJANOWSKI, Department of Anthropology, University of New Mexico, NM 87131

Current analyses of intracemetery biological variation focus on three primary sources of this variability:

variation due to differential sex-specific migration (postmarital residence), variation due to temporal subdivisions (microchronology), and variation due to lineage membership (kinship). Postmarital residence estimates parameters of the living population, while kinship and temporal studies attempt to illustrate those social and biological factors affecting cemetery formation. However, these approaches are heavily reliant on a priori subpopulation definition. Furthermore, little consideration has been given to aspects of cemetery structure, particularly as this relates to mobility and mate exchange within the living population that the skeletal assemblage represents.

I present a model for estimating the degree of biologically significant, distinct, population subgroupings buried within a single cemetery of homogenous spatial distribution. The model incorporates aspects of matrix correlation analysis and assumes a significant correlation between the interindividual biodistance and burial distance matrix. After internal standardization, a decomposition algorithm is executed resulting in a single residuals matrix, where the distributional properties of this output matrix provide information on biological variability and subdivision. In particular, the third moment is inversely proportional to the degree of population subdivision.

I test the assumptions of this analytical model using simulated data with consideration of pedigree relationships and lineage specific disposal areas. The results generally support my expectations. This type of analysis is useful for investigating changes in the size and extent of prehistoric mating networks in addition to aspects of population history such as mobility and settlement patterns.

What subspecies are they? Mitochondrial DNA and Y chromosome diversity in captive *Pan troglodytes*. A. C. STONE¹, R. BONNER² and C. M. LEWIS¹, M. HAMMER², ¹Department of Anthropology, University of New Mexico, Albuquerque, NM 87131, ²Laboratory of Molecular Systematics and Evolution, University of Arizona, Tucson, AZ 85721

The majority of *Pan troglodytes* that live in captivity are of unknown or uncertain subspecies. Recent research of molecular genetic markers in wild populations provides the opportunity to assess the origins of the captive population. Subspecies information and data on genetic diversity can aid in population management and are important for ongoing behavioral and other research of captive groups.

DNA was obtained from 121 chimpanzees in zoos and primate centers in the United States and Europe. Of these, the majority were wild born and imported from Africa prior to 1973. The mtDNA hypervariable region I (HVI) was sequenced in each individual. These data were analyzed with published data from wild populations in order to identify subspecies. The data indicate that most mtDNAs are derived from *P. t. verus*, although several *P. t. troglodytes* were also found.

Y chromosome sequences were examined in the eighty-one males in this sample, and several polymorphic sites were identified that appear to be subspecific, although a larger sample of *P. t. troglodytes* and *P. t. schweinfurthii* is necessary to verify these results. Together, the mtDNA and Y chromosome data suggest that several captive born individuals are hybrids. These data also indicate that mtDNA and Y chromosome diversity is higher in chimpanzees than in humans.

This research was supported by the Wenner-Gren Foundation for Anthropological Research, the National Science Foundation (SBR-9816508) and the University of Arizona.

Biocultural perspectives of maternal mortality in ancestral Pueblo populations. P.K. STONE, Department of Anthropology, University of Massachusetts, Amherst, 01003.

Empirical data on critical obstetrical dimensions of the pelvis combined with observations of occupationally-related muscular lesions on the skeleton can be used to test the hypothesis that constricted pelvic dimensions and/or patterns of hard labor contribute to early mortality for some women. These data combined with ethnographic information can then inform interpretations in ways that allow for a more holistic approach to understanding the quality (how well) and quantity (how long) of life in past populations.

The enduring history of populations in the American Southwest offers a unique opportunity to examine long-term patterns of health and lifestyle. This paper explores the relationships among reproduction, occupational stress, and mortality from eight skeletal samples (n=188) representing Ancestral Pueblo (Anasazi) peoples. Preliminary data suggests that compromised pelvic shape contributed to early death for some young women while older individuals appear to have uncompromised pelvic dimensions. While maternal mortality is assumed to be the primary factor in the early deaths of reproductive age women, examination of women's lifestyle and stresses can be used to reveal a myriad of factors beyond pregnancy and parturition that contributed to young women's mortality.

In this paper skeletal data is combined with ethnographic information on birth process, birth-spacing, corn grinding, and other facets of reproduction and work to uncover the complex relationship between pregnancy and parturition, workload and cultural practices and the incidence of early death for young women. Utilizing this biocultural approach to women's reproductive health will, in turn, contribute to a better understanding of the combined effects of reproduction and work patterns on women's bodies and women's lives in the past as well as the present.

The locomotor anatomy of hominoid and hominid ancestors. D.S. STRAIT, B.G. RICHMOND, Dept. of Anthropology, The George Washington University, 2110 G St. NW, Washington, DC 20052, and J.D. POLK, DPAS, SUNY at Stony Brook, NY 11794.

Although scenarios describing the evolution of ape locomotion are substantially constrained by phylogenetic patterns, the specific implications of phylogeny have rarely been discussed in detail. This study describes these implications by using cladistic methods to reconstruct the locomotor anatomy of hypothetical ancestors specified in recently published hominoid phylogenies.

Ingroup taxa included humans, the extant apes, *Proconsul*, *Equatorius*, *Oreopithecus*, *Dryopithecus*, *Sivapithecus* and *Praeanthropus* (= *Australopithecus afarensis*). Outgroup taxa included *Alouatta*, *Pliopithecus*, *Papio*, *Macaca* and *Victoriapithecus*. 80 characters thought to be functionally related to locomotion were examined. Ingroup taxa were forced to fit the tree topologies specified by recent phylogenetic studies. For each tree, the character states reconstructed as being present in five last common ancestors (LCA) were recorded. Those ancestors include the LCA of 1) all hominoids, 2) extant hominoids, 3) great apes and humans, 4) African apes and humans, and 5) chimpanzees and humans.

Although the five cladograms differ in their branching patterns, they imply consistent patterns of character evolution in hominoid locomotor anatomy. The LCA of all hominoids was a generalized arboreal quadruped with few apomorphies. There is no evidence that it had suspensory adaptations. Locomotion in the LCA of extant hominoids depends critically on the phylogenetic relationships of *Equatorius*. If this genus diverged prior to *Hylobates*, then the LCA was highly suspensory, but not necessarily a brachiator. However, if *Equatorius* diverged after *Hylobates*, then the locomotor mode of this ancestor is ambiguous. The LCA of great apes and humans was suspensory, and probably exhibited bridging behavior not seen in the LCA of extant apes. This result is obtained regardless of the phylogenetic position of *Sivapithecus*. The LCA of African apes and humans had terrestrial adaptations imposed on a suspensory body, and was probably a knuckle-walker. The LCA of *Pan* and *Homo* is identical to the LCA of African apes and humans.

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Preliminary assessment of Marfan syndrome in individuals from the Stanford-Meyer Human Anatomy Skeletal Research Collection. D.W. STRATMANN, S. L. WHITE and R.G. FRANCISCUS, The University of Iowa, Iowa City, IA 52242

Marfan syndrome (MFS) has been provisionally diagnosed in two individuals from the Stanford-Meyer Human Anatomy Skeletal Research Collection now housed at the University of Iowa.

MFS, a congenital disorder of the connective tissue, manifests in the skeletal, ocular and cardiovascular systems affecting roughly one in 20,000 people. MFS is autosomal dominant but can also occur as a random point mutation. Because the gene is pleiotropic there is a great deal of

variability expressed in the phenotype. Usually cited among its skeletal characteristics are excessive growth of the long bones and abnormalities of the spine and ribs. Nonetheless, the variability in MFS makes it difficult to diagnose in hard tissue, particularly in partial skeletons.

Three individuals in our study were initially identified with axial and appendicular features symptomatic of MFS. Subsequent metric and non-metric differential diagnosis indicated that two of the three individuals likely had MFS. A third individual, initially thought to have had MFS because it manifested several features attributed to the syndrome, was determined non Marfan due to the absence of other key MFS associated features.

The purpose of this study is to refine and amend a suite of metric and non-metric skeletal characteristics for a syndrome usually identified only *in vivo* that would aid in a more accurate assessment of this syndrome in skeletal populations. The documented prevalence of MFS in clinical studies indicates that it could be more widespread in cemetery populations and existing skeletal collections. A more accurate assessment of the prevalence of MFS in skeletal remains would give us a clearer picture of the syndrome in historic and possibly prehistoric context.

Histological stress indicators in Late Pleistocene hominid diaphyseal bone. M. STREETER, S.D. STOUT, Dept. of Anthropology, Univ. of Missouri-Columbia, Columbia, MO 65211, and E. TRINKAUS, Dept. of Anthropology, Washington Univ., St. Louis, MO 63130.

The non-specific stress indicator, dental enamel hypoplasias (DEH), has been observed to occur at higher frequencies in late archaic *Homo* (Neandertals) than in the earliest modern humans. Neandertal mortality patterns and trauma rates also suggest high degrees of population level stress.

Type II osteons, histological indicators of bone remodeling, have been attributed to intraosteonal remodeling in response to the demands of mineral homeostasis. The purpose of this study is to assess the relative amount of these histologically observable stress indicators in a sample of diaphyseal cortical bone from five Neandertals (Shanidar 3, 4, 5, & 6 and Tabun 1) and two early modern *Homo sapiens* (EMHS), Skhul 6 and 7, all from the Near East. The average relative occurrence of Type II osteons was found to be lower in the EMHS group than in the Neandertals, but the Neandertals show a wider range encompassing that of the EMHS group. There is no evidence of intergroup differences but there does appear to be a high degree of individual difference within the Neandertal sample.

These histological data from a limited sample of Late Pleistocene hominids therefore support, but do not by themselves establish, the pattern observed in other indicators of stress.

Hormonal and social correlates of life history in male muriquis (*Brachyteles arachnoides*). K.B. STRIER, Department of Anthropology, University of Wisconsin-Madison, 53706, and T.E. ZIEGLER, Wisconsin Regional Primate Research Center, University of Wisconsin-Madison, 53711.

Compared to other primates, male muriquis (*Brachyteles arachnoides*) maintain unusually peaceful relationships within their philopatric societies, even during the annual breeding season when ovulating females are present. We analyzed fecal testosterone and cortisol levels from six wild male muriquis (*Brachyteles arachnoides*) over a 19-month period at the Estação Biológica de Caratinga, Minas Gerais, Brazil, to investigate the hormonal correlates of their social and reproductive behavior. We found no differences in mean testosterone levels between mating and nonmating seasons or between rainy and dry seasons. However, mean cortisol levels changed with sexual activity, and were significantly higher during the second dry season, when mating continued after a heavy rainfall year, than during the first dry season, when all mating ceased.

Individual males differed in the timing of their hormone shifts relative to their sexual activities, as measured by their first and last observed copulations each year and their copulation frequencies. However, comparisons among young adult (10-12 years, n=2), middle-aged (14-15 years, n=2), and mature males (>19 years, n=2) revealed that neither hormone levels nor sexual activities were related to male age.

We found no evidence of prebreeding increases in cortisol in any male. This finding, together with the lack of seasonality in testosterone levels, may be related to the low levels of aggression that muriqui males of all ages exhibit throughout the year. How individual differences in cortisol profiles correlate with the variation in male diets, ranging, and energetic requirements remains to be examined.

Fieldwork supported by NSF, Chicago Zoological Society, Liz Claiborne & Art Ortenberg Foundation, Lincoln Park Zoo, and WARF, UW-Madison; Assay costs funded by NSF and the Wisconsin Regional Primate Research Center.

BIRTH DEFECTS: NOT ANOTHER POLYDACTYLY ...PLEASE... Judith Sture, Archaeology, University of Durham, England.

Barnes (1994) and Sture (1997, unpublished dissertation) have addressed the congenital diseases from an analytical, rather than a case study, perspective. The analysis of birth defects in skeletal material offers far more information about human health in the past than simple case studies. Focusing on English Medieval rural and urban sites, large samples from Raunds Furnells and Chichester were assessed for frequency of defects of the axial skeleton. Significant differences were observed in the overall frequency of defects, and also in specific defects. Age-at-death was lower amongst affected individuals and some gender preference was noted. These results are interesting not least because the defects were invisible and

those affected would not have been aware of any bony anomaly.

By comparing the observed defects with modern clinical data it is possible to predict associated soft-tissue irregularities which would be otherwise invisible to the biological anthropologist. Estimation of past rates of some forms of congenital heart disease and other organ anomalies, along with rates of mental retardation, cosmetic problems, and neurological anomalies, may be possible.

The differences between rural and urban defect frequencies (urban were highest) beg the question: why? It is suggested that a higher rate and range of infection were experienced by urban dwellers, associated with diet, water supply, sanitation, housing and possibly industrial activities. Nutritional and immunological impairment as a result of, or enhancing, infection, may be acting on the unborn fetus and possibly affecting genetic conformation also.

Skeletal congenital defects therefore offer insights into past nutritional efficiency, immunological status, exposure risks, soft-tissue anomalies and the standards of living of previous generations. This study will also prove useful in the field of modern epidemiology. Supported by a grant from the British Academy, London, England.

Y chromosome evidence for a northward migration of modern humans in East Asia during the last Ice Age. B. SU, J. M. AKEY, R. CHAKRABORTY, and L. JIN. Human Genetics Center, Univ. Texas School of Public Hlth., Houston, TX.

The timing and nature of the arrival and subsequent expansion of modern humans into East Asia remains controversial. We investigated the ancient human migration patterns in East Asia using 19 Y-chromosome biallelic markers. Our data indicates that southern populations in East Asia are much more polymorphic than northern populations who have only a subset of the haplotypes found in the southern populations. This pattern suggests that the first settlement of modern humans in East Asia occurred in the mainland of Southeast Asia during the last Ice Age, coinciding with the absence of human fossils in East Asia between 50,000-100,000 years ago. Following the initial peopling a great northward migration extended into northern China and Siberia. (Research supported by grants from NIH GM 41399 and Li Foundation).

Distribution and diversity of primates in Guyana. R.W. SUSSMAN, Department of Anthropology, Washington University, St. Louis, MO 63130, J. PHILLIPS-CONROY, Department of Anatomy and Neurobiology, Washington University Medical School, St. Louis, MO 63110, and S.M. LEHMAN, Department of Anthropology, SUNY-Stony Brook, Stony Brook, NY 11794.

Compared to our understanding of primate social systems and diet, we know relatively little about the

ecological biogeography of primates. The effects of area and ecological specialization on species richness are an integral part of biogeographic studies. Species-area relationships predict that there is a positive relationship between the number of species and the size of an area. It has also been suggested that species that exploit a wide range of resources (generalists) are locally common and widely distributed whereas species that exploit a narrow range of resources (specialists) have a limited distribution and are locally uncommon. However, there are few data on the ecological correlates of primate distribution and diversity, particularly in South America.

We used data from 2095 km of primate surveys conducted from 1994-1997 to determine the distribution of eight primates species in Guyana. Geographic ranges were estimated for each species using a GIS system. The GIS system was also used to determine the size and diversity of major primate habitats in Guyana.

Geographic range size is a significant determinant of the number of primate species sighted and primate sighting rates in Guyana ($R=0.656$, $p=0.015$). Primate species diversity is highest in large habitats, such as rain forest and southern hill-land forest, and lowest in small habitats, such as palm marsh and swamp woodlands. Interfluvial area is most highly correlated with species diversity ($R=0.916$, $p=0.04$). Generalist species are both locally common and widely distributed, whereas specialist species had a limited distribution and tended to be locally uncommon. Ecological factors play an important role in influencing primate biogeography in Guyana.

A blind test of subadult skeletal sexing techniques using known-sex mummies from the Azapa Valley, Chile: a preliminary report. R.C. SUTTER, Department of Sociology and Anthropology, Indiana-Purdue University at Fort Wayne, Fort Wayne, IN 46805.

This research reports on a blind test of the assignment of sex using previously proposed non-metric techniques (Schutkowski, 1993; Weaver, 1990) for the sexing of juvenile and fetal skeletal remains. These techniques rely upon sexually dimorphic morphological traits of the juvenile pelvis and mandible. Pelvic traits include the angle and depth of the sciatic notch, iliac arch criteria and crest curvature, elevation of the auricular surface, and presence of the preauricular sulcus. Mandibular traits include mandibular protrusion, arcade shape, and gonion eversion.

The skeletal remains of 85 subadult mummies of known sex from the Azapa Valley, Chile were examined for the presence or absence of each of these nine traits. The ages of these remains ranges from fetal to fifteen skeletal years. Sex was assigned by first serializing then scoring each of the nine traits independently without prior knowledge of the sex of the skeletal elements being examined. The accuracy of each skeletal trait is evaluated using Chi-square analysis of the assigned sex and the actual sex of the individual.

While all nine traits examined by this study produced significant results, not all of these traits are useful for the assignment of sex among pre-Colombian juvenile remains.

In general, males are correctly identified more often than females for traits examined by this study with the only exception being gonial eversion. The arch criteria, iliac crest curvature, and sciatic notch angle and depth are most useful for the correct assignment of sex for both males and females. The preauricular sulcus, auricular elevation, and mandibular arcade shape are useful for the correct assignment of sex for males, but perform only slightly better than chance for the correct identification of females. Mandibular protrusion is useful for the assignment of sex for males, but is of no value in the correct identification of females. Although it produces a statistically significant result, gonial eversion is only slightly better than chance for the correct identification of sex for both males and females. This trait is of limited use. The significance of these results for Andean bioarchaeology are discussed.

Upper Paleolithic Moravia between East and West: aspects of settlement pattern, subsistence and technology. J. SVOBODA, Czech Academy of Sciences – Institute of Archaeology, 69201 Dolní Věstonice 25, Czech Republic.

This presentation will examine the interconnecting role of the Moravian geographic corridor during the Upper Paleolithic in an European context: it suggests that the importance of this particular area has increased as a result of the formation of Eastern European cultural centers.

In a more detailed view, the use of landscape in Moravia by the various Upper Paleolithic cultures is so variable that we may talk of an "Aurignacian landscape" (highland/lowland marginal areas), a "Gravettian landscape" (river valleys) and a "Magdalenian landscape" (karst).

In the Gravettian, the formation of large hunter's settlements, including hearths, huts and associated mammoth-bone deposits, along the strategic points of the river valleys allows us to address broader economic problems and ask about the level of social complexity. The Gravettian system, oriented on exploitation of long-distance lithic materials, and of the largest (mammoths) and smallest (hares, carnivores, birds) animals, seems more labor-expensive compared to the other hunting-gathering cultures in the same region. It seems to have been supported by new technologies (ceramics, textiles, polishing stone, fuel) as well as by symbolism and complex rituals (ceramic production and destruction, ritual burials).

Gradient phenomena, hominoid body plans, and locomotor function. D. SWARTZ, Seton Hall University, New York.

The literature on primate development and locomotion (e.g., Grand, 1977; Zihlman and Bruner, 1979; Rollinson and Martin, 1981; Berge, 1998) has stated that changes in segment proportions and centers of mass during ontogeny are crucial to attaining mature locomotor function. The actions of the developmental

gradients along the body's main axes and in the limbs are largely responsible for these changes (Lumer and Schultz, 1941; Tanner, 1960; Fleagle and Samonds, 1975; Sinclair, 1978). In ontogeny, segment proportions are also modified by biomechanical forces, which perfect balance and energetic efficiency (Amtmann, 1979; Norkin and Levangie, 1983; Berge, 1998). The evolution of new body plans, with altered proportions and centers of mass is apparently accomplished by altered gradient actions. New body plans would be subject to new biomechanical forces.

The reality of gradient interactions, with relative trunk broadening significantly correlating with antero-posterior steepening (increased skull length/tail length and increased intermembral index) was demonstrated among 692 adult primate and tupaiid skeletons, regardless of weight or function (Swartz, 1993). Apes express the "trunk broadening - tail shortening - intermembral index increase" most extremely. Steepened disto-proximal within-limb gradients (long distal and short proximal segments) parallel antero-posterior steepening in the main axis. Thus, an ape's body plan has a high center of mass (promoting efficient climbing) and long cheiridia for powerful grasping during suspension. *Homo* has a narrower trunk and lower intermembral index (antero-posterior flattening) and disto-proximal within-limb gradient flattening. With a lower center of mass, stable stance, with an extended adducted lower limb, is facilitated. Resultant forces produce lumbar lordosis, iliac curvature and a valgus knee.

Social interactions among female hamadryas baboons (*Papio hamadryas hamadryas*): Implications for the evolution of hamadryas baboon social organization. L. SWEDELL, Ph.D. Program in Anthropology & NYCEP, Columbia University, New York, NY 10027.

Previous research on wild hamadryas baboons has indicated that females direct most of their social interactions toward their leader male and interact very little amongst themselves. Results from this study, however, indicate that most female hamadryas spend as much social time with other females as they do with their leader male, suggesting that social interactions among females play a greater role in hamadryas social organization than has previously been thought. Observational data from a group of 170 wild hamadryas baboons in Ethiopia indicate that the size of a one-male unit is positively correlated with a female's tendency to interact with other females in her unit. Females vary widely in their frequency of social interaction with other females, and females who do spend social time with other females do so at a relatively equal frequency whether or not their leader male is available for social interaction. Differences among females in their tendency to interact socially with other females may be a function of the relative strength of social bonds between female dyads, which may be based on kinship. Although hamadryas have generally been described as a species in which males are philopatric and females disperse, recent microsatellite data from this population show a higher level of relatedness among

females than typically exists for the dispersing sex in other taxa (Woolley-Barker, 1999). Hamadryas females may thus be more philopatric than has previously been thought. The forced transfer of females between one-male units and groups restricts female philopatry and limits the development of long-term relationships among females, whether or not these relationships are based on kinship. Nonetheless, results from this study suggest that the ability and motivation of females to form and maintain bonds with other females was not completely lost during the evolution of hamadryas baboons from their savanna-dwelling ancestors. This research was supported by the National Science Foundation (SBR-9629658), the Wenner-Gren Foundation for Anthropological Research, the L.S.B. Leakey Foundation, the National Geographic Society, and the New York Consortium in Evolutionary Primatology.

Do big females have big pelvises? R.G. TAGUE, Department of Geography and Anthropology, Louisiana State University, Baton Rouge, LA 70803.

Previous studies have shown that tall females have bigger pelvises and enhanced reproductive efficiency relative to short females. This study addresses the issue of body size and obstetric advantage. The relationship between pelvic size and body size is determined for females and males. The skeletal sample consists of blacks, whites, and Native Americans. Twenty-eight measures and indices of the pelvis, femoral length and head diameter, and clavicular length are analyzed. Each pelvic variable is subjected to multiple regression analysis, with the three nonpelvic measures serving as independent variables. The coefficient of multiple determination (CMD), which is the square of the multiple correlation coefficient, and partial correlation coefficients are computed. The results show that the CMDs range from 3% to 33% in females and from 0% to 42% in males. The sexes are broadly comparable in both their CMDs and partial correlations. Of the six pelvic variables that are significantly different between the sexes in their CMDs, five are of the midplane. The preponderance of significant, positive partial correlations for the pelvic variables are with femoral head diameter and clavicular length, not with femoral length. The results are explained as follows. As pelvic size is at the minimum at the midplane, the sexual differences in CMDs are the result of selection with respect to obstetrics. Nevertheless, though big females and big males generally have big pelvises, selection for an obstetrically sufficient pelvis is not a simple concomitant of selection for large body size. The importance of body size with respect to obstetrics in prehistory is discussed.

New primate fossils discovered from the late Middle/ Late Eocene of the Pondaung Formation, Central Myanmar. M. TAKAI¹, N. SHIGEHARA¹, A.K. AUNG², A.N. Soe³, S.T. TUN², T. TSUBAMOTO⁴. ¹Primate Res. Inst. Kyoto Univ., Japan. ²Dept. Geology, Dagon Univ., Myanmar. ³Dept. Geology, Univ. of Yangon, Myanmar. ⁴Dept. of Geology, Kyoto Univ., Japan

Since the beginning of this century, the Pondaung Formation of Central Myanmar (=Burma) has been well known for producing many Late Eocene mammal fossils including two enigmatic primates, *Pondaungia* and *Amphipithecus*. During the 1998 field season, two additional primate fossils were discovered from Pondaung area by Myanmar-Japan Fossil Expedition Team: one is the maxillozygomatic fragment with several upper teeth of *Pondaungia* and the other is a pair of upper and lower dentition of a new taxon.

The new specimen of *Pondaungia* was collected at Pangan village (near the type locality) and preserves I¹, C, root of P², P^{3,4}, M², and fragments of M¹ and M³. The specimen retains a very robust zygomatic arch and canine is also very robust and oval in occlusal view. Upper premolars are relatively small with respect to molars. M² is much larger than that of the type specimen, suggesting a sexual dimorphism in *Pondaungia*.

Other new primate specimen consists of upper dentition (P⁴-M³) and two mandibular fragments with C-P₃ and with M_{2,3}, respectively. It was discovered at Bahin village, where a new specimen of *Amphipithecus* was discovered in 1997. This new taxon differs from *Amphipithecus* and *Pondaungia*, in its much smaller size, in having a cingulum-derived hypocone, and in having a very short trigonid on M₂.

These new findings suggest that all Pondaung primates are far related to two main fossil prosimian groups, adapoids and omomyioids, and should be classified into the Anthropoidea.

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Bioarchaeological analysis of culturally-modified osseous remains. J. A. TALavera, J. M. ROJAS, and E. GARCIA, Bioarchaeological Team of DAF-INAH.

This study presents a strategy for bioarchaeological analysis of culturally-modified osseous remains that the authors are currently developing in Physical Anthropology at the National Museum of Anthropology and History, Mexico City. During this research we have performed experiments to replicate the technology and function of tools and ornaments

manufactured from human bones, in order to evaluate technological and morphological aspects of this bone industry. The analysis includes human bone artifacts from archaeological sites across Mesoamerica dating from 600 B.P. to A.D. 1521.

Patterns of resource use in three sympatric *Hapalemur* species in Ranomafana National Park, Madagascar.
C. L. TAN, Doctoral Program in Anthropological Sciences, SUNY at Stony Brook, NY 11794-4364.

Natural selection favors differentiation of ecological niches between closely related sympatric species. In extant primate communities, sympatric and syntopic congeneric species with strict diet specializations are virtually non-existent, except possibly for three prosimians: *Hapalemur griseus* (0.9 kg), *H. aureus* (1.5 kg), and *H. simus* (2.4 kg). To examine the degree of resource overlap among *Hapalemur* species, I conducted the first simultaneous comparative study of the three congeners in Talatakely, Ranomafana National Park, Madagascar.

I studied two groups of *Hapalemur griseus*, two groups of *H. aureus* and one group of *H. simus* from September 1996 to May 1999 for a total of 32 months. I collected data using 5-minute instantaneous focal animal sampling.

Results indicate that all three *Hapalemur* species are diet specialists; over 80% of their total feeding records consist of bamboo. Despite considerable dietary overlap among the three *Hapalemur* species, *H. simus* greatly contrasts with *H. griseus* and *H. aureus* in food choice, habitat use, and activity rhythm. Unlike the other two species, *H. simus* does not rely on bamboo young leaf bases and branch shoots throughout the year. Instead, *Hapalemur simus* switches from mainly eating shoots of *Cathariostachys madagascariensis* in the wet season to culm pith and mature leaves of this bamboo in the dry season. The latter two food items are never ingested by *Hapalemur griseus* and *H. aureus*. In addition, there is a positive correlation between the body size of *Hapalemur* species and the size of bamboo shoots they select; *H. simus* eats significantly larger diameter of shoots (mean = 6.0 cm) than *H. aureus* (mean = 2.1 cm) and *H. griseus* (mean = 0.8 cm). Whereas the two smaller *Hapalemur* species utilize their entire home ranges on a weekly basis, *H. simus* concentrates its activities in a small core area for one to two weeks. The use of forest strata further distinguishes *Hapalemur simus* from *H. griseus* and *H. aureus*. *Hapalemur simus*, compared to its sister taxa, is relatively more terrestrial and forages/feeds at lower levels of the understory (c.a. 5 m). All three *Hapalemur* species are predominantly diurnal. *Hapalemur simus*, in addition, exhibits night-time activities regardless of luminosity.

Almshouses of New York State: Living for the Moment TARRICONE, F.C., KILLORAN, P.E., and O'BRIEN, T.G. Dept. Of Anthropology, Binghamton University and Public Archaeology Facility, Binghamton, NY 13902-6000.

Records from the Broome County Poorhouse have been analyzed and

compared with census data from the rest of the county as well as the entire state. Length of stay was calculated for all paupers who died in the poorhouse. In the sample period from 1900-1910, several trends were identified. More than 30% of the paupers in this sample died within 30 days of entering the poorhouse, and over 50% died within six months. Deaths were relatively low for individuals between the ages of <1 and 39 years, which contrasts with the high frequencies of infant and child mortality seen in the rest of the county. The length of stay appears correlated with age at admission, so that younger paupers were more likely to have shorter lengths of stay before their death, while those that entered the poorhouse at a later age had a better chance of surviving for at least one year.

We suggest that the Broome County Poorhouse became an institution for the infirmed and/or elderly to go to die and less as an institution to aid the poor. We attribute the short length of stay for the majority of inmates to their poor state of health before entering the poorhouse, while the greater length of stay seen in the elderly suggests that they were placed in the poor house mainly due to their age, despite good health.

The overall picture of the Broome County Poorhouse is one of high mortality and a short length of stay for most inmates. While Broome County is smaller and more rural than most other regions, it was used as a model for the rest of the state, suggesting this pattern was also the case for a much larger region.

Causes of variation in the human vertebral neural canal: pathological condition or not? N.E. TATAREK.
Department of Sociology and Anthropology, Ohio University, OH. 45701.

Based on a study of prehistoric Native North Americans, Clark (1985) indicated that the size of the neural canal could provide evidence of childhood stress, poor health and even an early age at death. In addition, copious amounts of clinical research demonstrates that spinal stenosis (a small or restrictive canal) can be a significant factor in stress, health and recovery from trauma, especially spinal injuries. Some work (eg Torg, 1998) utilizes the size of the neural canal to evaluate athletes for the likelihood of sports related spinal injuries: individuals with canal sizes below a certain cut point (spinal stenosis) are warned of the risk of a severe injury.

However, the range and nature of variation in the size of the human vertebral neural canal is not well understood by either anthropologists or physicians. Many studies do not consider age, ancestry or individual vertebral levels in their all encompassing 'cut points.' The goal of this research was

to examine the variation in the human vertebral neural canal and to determine what levels, if any, might indicate pathological conditions in the canal (spinal stenosis). Utilizing the Hamann-Todd and Terry skeletal collections, data were collected on 321 adult vertebral neural canals from the second cervical vertebrae to the first sacral element. Following Clark (1985) and others, measurements of the anterior-posterior and transverse neural canal were taken.

The normal curve was utilized to construct cut points for stenotic and average canal sizes. Discriminant function, multiple regression and chi-square likelihood were used to analyze the variation in neural canal size with respect to age, ancestry, stature and long bone length. For individuals 40 years or less, a restrictive canal was slightly related to an earlier age at death and differences in stature and long bone length. Stenosis in older individuals was related to the process of senescence. In addition, this study clearly demonstrated significant differences in canal size related to sex and ancestry.

Tooth or consequences: Is jaw robusticity the correlated effect of increased tooth size? A.B. TAYLOR, Department of Physical Therapy, Samuel Merritt College, Oakland, CA 94609.

Recent studies have revealed differences in jaw morphology within and between African apes. These morphological differences have been hypothesized to be the predictable consequences of dietary variation. In particular, more folivorous apes are expected to exhibit adaptations of the masticatory complex, including a more robust mandibular corpus, to both resist greater occlusal loads associated with the mechanical demands of a leafy diet and increase masticatory efficiency. Indeed, these predictions have been borne out by the data.

However, corpus robusticity is determined by a number of factors, including the spatial demands of the dentition and, in particular, the developing dentition. Thus, in assessing jaw form and function, it is desirable to attempt to separate the effects of diet from dental size.

I calculated partial correlation coefficients for jaw and tooth dimensions in ontogenetic series of *Pan* (*P.t. troglodytes*, n = 61; *P.t. schweinfurthii*, n = 73; *P.t. verus*, n = 70; *P.paniscus*, n = 59) and *Gorilla* (*G.g. gorilla*, n = 57; *G.g. graueri*, n = 42, *G.g. beringei*, n = 25). I hypothesized that if tooth size is largely driving corpus robusticity, then correlations between tooth and jaw dimensions (while controlling for the effects of skull size) should be significant.

Partial correlation analyses reveal tooth size has a significant effect on jaw robusticity in most taxa. However, the correlation coefficients tend to be lower in *Gorilla* vs. *Pan*. These results indicate that although gorillas are characterized by a relatively larger postcanine dentition, less of the variation in jaw robusticity can be explained by tooth size in gorillas compared to chimpanzees.

This research was supported by a grant from the LSB Leakey Foundation.

Social Behavior of Aged Lemurs. L.L. TAYLOR, Department of Anthropology, University of Miami, Coral Gables, FL 33124-2005

The behavior of aged primates is an important area of investigation, however aged prosimians have been little studied to date. More than 500 hours of focal animal sampling were gathered at the Duke University Primate Center on diurnal, socially-housed, aged lemurs and their younger cage mates. These data were used to test hypotheses concerning aging and social behavior. Focal animal sampling was used to gather data on the acts per hour (APH) of affiliative behaviors and aggression. Both aged and younger animals were overwhelmingly social, being scored in proximity to others 66% and 60.9% of samples respectively. Overall, aged animals were less likely to initiate affiliative behaviors than younger animals (6.8 vs. 24.3 APH). Oldsters were rarely the target of aggression (1 APH) were also much less likely to initiate aggression (3 APH) in comparison to younger lemurs (5 APH). Sex differences were apparent in that aged females had priority of access to food and resting sites over all younger animals, whereas older males did not. These data support the hypothesis that aged lemurs are not as actively involved in social interactions, in comparison to younger animals, because they chose to initiate interactions less often. These results also suggest that younger animals may not target older animals for aggression as a means of gaining priority of access and status.

This research was supported in part by a James W. McLamore award from the University of Miami.

Tooth use and microwear in Prehistoric North America: The perspective from scanning electron microscopy. M.F. TEAFORD, Dept. of Cell Biology & Anatomy, Johns Hopkins University, Sch. of Medicine, Baltimore, MD 21205, C.S. LARSEN, Dept. of Anthropology, University of North Carolina, Chapel Hill, NC 27599, D.L. HUTCHINSON, Dept. of Anthropology, East Carolina University, Greenville, NC 27858.

Dental microwear analysis has the potential to shed light on changes in diet within species. One of the most

well-documented changes in human diet is the transition from hunting-gathering to maize agriculture in native North American populations. Dental microwear analyses have already proven useful in such work, but the purpose of this study was to see if they could document differences in that dietary transition between archeological sites.

High resolution dental impressions were taken from the maxillary first and second molars of archeological remains from the Southeastern U.S. "President Jet Regular" polysiloxane (Coltene-Whaledent) was used to take all impressions, and epoxy casts were examined under an AMRAY 1810 scanning electron microscope. Micrographs were taken of the crushing areas on M¹ and M² at a magnification of 500X. All micrographs were analyzed using Microware 3.0 (Ungar), yielding average pit widths, scratch widths, number of features per micrograph, percentage pits, and degree of orientation of scratches for each micrograph. Measurements were compared between samples using ANOVA and Tukey's HSD test.

Results reinforced the idea that dental microwear analyses can shed light on the transition to maize agriculture in North America. However, those results also varied from archeological site to site, indicating that exogenous grit in different environments (e.g., coastal vs. estuarine environments) can also affect dental microwear analyses.

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The Effect of Habitat on Fecal Cortisol Concentrations in Squirrel Monkeys (*Saimiri sciureus*). S.R. TECOT, Physical Anthropology, University of Texas at Austin, TX 78712-1086

Squirrel monkeys (*Saimiri sciureus*) are highly sensitive to subtle environmental changes, and excrete high levels of cortisol in response to stress. Stress associated with captive environments may have had an impact on early failed attempts to house squirrel monkeys. This study looked at the effects of habitat on cortisol output. Mean fecal cortisol was used as an indicator of stress in squirrel monkeys from four different habitats: a caged zoo environment (Austin Zoo), a lab with indoor/outdoor runs (University of South Alabama Primate Research Laboratory), an urban refuge with free-ranging animals (The Bonnett House), and a captive "rainforest" environment (Monkey Jungle). The goal of this study was to: 1) describe and make comparisons of the stress levels of populations in differing environments, 2) determine whether certain environments are more stressful, and 3) generate hypotheses relating to the socioecological factors influencing stress levels in this species.

Fecal cortisol concentrations were measured using a cortisol enzyme immunoassay (EIA) at the Wisconsin Regional Primate Research Center's Assay Services Laboratory. There were large differences in mean fecal cortisol across all locations, where caged groups had higher concentrations than uncaged. Statistical analyses showed significant differences in mean fecal cortisol across all locations except the zoo, probably due to small sample size. The urban refuge had the lowest cortisol levels and the lab had the highest levels. These findings suggest that the

prolonged effects of stress in *S. sciureus* are greater in less naturalistic habitats. Further research is needed to investigate this variation and its implications for captive welfare. This is the first study measuring squirrel monkey fecal cortisol.

Musculoskeletal indicators of work stress in enslaved Africans in Colonial New York: functional anatomy of the axial and appendicular skeleton. C.J. TERRANOVA, Howard University, Washington, DC 20059, C. NULL, University of Massachusetts, Amherst, MA 01003, K.J. SHUJAA, University of Pennsylvania, Philadelphia, PA 19104 and E.G. MEDFORD, Howard University, Washington, DC 20059.

The skeletal samples excavated from the New York African Burial Ground affords unique insights into the biology and work environment of enslaved Africans in eighteenth century New York. Here, we report on the distribution and nature of discrete and continuous variables identified in the axial and appendicular skeleton that are indicative of functional loading. Coupled with historical information about the execution of work-related tasks, our analyses are aimed at elucidating: 1). sex and age differences in the extent and distribution of vertebral and long bone indicators, and 2). functional correlates of specific suites of morphological features.

The sample used for these analyses is composed of 159 individuals (87 male, 72 female) from the New York African Burial Ground (NYABG). Contrasts are made within specific age classes. Analyses of the nature and extent of hypertrophied muscle scars are made in respect to body size.

We present evidence of the nature of work performed by enslaved Africans in eighteenth century New York. Men and women appear to have performed somewhat different tasks; for example, the cervical vertebrae of women are more likely to exhibit morphologies consistent with overloading of the neck while carrying items on the head. Additionally, we discuss our attempts to quantify the extent of load-bearing, especially in the lower limb and lumbar region of the trunk. Future examinations of the functional anatomy of the individuals will further elucidate the physical demands placed on their skeletons.

Strontium isotope ratio measurements in prehistoric Austrian human bone samples using high-resolution inductively-coupled plasma spectrometry (HR-ICPMS). M. TESCHLER-NICOLA, T. PROHASKA, C. LATKOCZY, F. GEROLD, M. WATKINS, AND G. STINGEDER, Natural History Museum and University of Agricultural Sciences, Vienna, Austria.

In previous studies, we have analyzed strontium isotopic ratios (⁸⁷Sr/⁸⁶Sr) in prehistoric human bone

samples of the linear pottery settlement of Aspam/Schletz, Lower Austria, by means of ICPSFMS (Finnigan MAT Element, precision below 0.03% [RSD for $n=5$]). The striking similarity in isotopic patterns for single individuals suggests that they belonged to the same settlement and were of indigenous provenance. Significant differences in the bone microstructure for single skeleton samples raise the question of specific deposit conditions responsible for alterations in strontium isotopic ratios within the human bone. To clarify whether living conditions of an individual (*intra vitam* uptake) cause different isotopic ratios, or if post-mortem processes significantly alter these ratios, this research investigates isotopic ratios of biological samples (teeth versus bones) in reference to soil samples. For the evaluation of diagenetic changes in ancient human skeletal remains, we used skeletons from three extremely different regions in Lower Austria: i) the excavation site of Schletz, repository material is loess; ii) the excavation site of Franzhausen, repository material is river gravel; and iii) of the excavation site Gars, repository material is gneiss.

Soil samples contain a non-negligible amount of rubidium, which leads to a spectral interference of ^{87}Rb with ^{87}Sr signal, a prior separation of rubidium from strontium has been developed as a necessary technical prerequisite.

This approach has been applied to analyze stable isotope ratios in human skeletal remains (of the above mentioned three selected ancient series) but also in soil and rock samples, which clarifies possible diagenetic influences as prerequisite for the reconstruction of migration patterns in ancient human populations.

Food resource characteristics in two nocturnal lemurs with different social behavior: *Avahi occidentalis* and *Lepilemur edwardsi*. U. THALMANN, Anthropological Institute, University of Zürich, CH-8057 Zürich, Switzerland.

Results of a comparative field study on the feeding behavior of two nocturnal lemurs, the gregarious *Avahi occidentalis* and the "solitary-but-social" *Lepilemur edwardsi*, are presented. The goal of the study was to take *Avahi* and *Lepilemur* in a model comparison in which many variables are constant (activity period, body weight, habitat, positional behavior, gross diet), to assess hypotheses linking group size and social organization to food resource characteristics. Both lemur species feed predominantly on leaves but show selective feeding behavior. Virtually no overlap in food resources is present, once resource size and seasonality have been taken into account. Food selection by *Avahi* is characterized by under-represented resources and a high degree of exploitation. It is worthwhile - and probably imperative - to defend those resources. Their location must be known exactly for repeated use. This imposes ranging limitations on male *Avahi* and could favor a preference of female *Avahi* for a familiar mate likely to defend the rare

resources and share "knowledge" of them. A stable monogamous pattern could be the optimal solution in such a case for both male and female. Food selection by *Lepilemur* is based on common resources to a higher degree, and a lower degree of exploitation is shown. *Lepilemur* males would hence be less restricted and could potentially opt for a different strategy from that of *Avahi*. It is as yet unclear whether such a strategy is realized or not. Other possible correlates of monogamy in primates are discussed.

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Human Y chromosome variation across England and Wales. M.G. THOMAS, The Centre for Genetic Anthropology, Depts. of Biology and Anthropology, Darwin Building, University College London, Gower Street, London WC1E 6BT, and D.A. WEISS, Dept. of Anthropology, UC Davis, Davis, CA 95616.

The history of England and Wales documents a complex series of migrations and invasions that brought together a diverse set of peoples with different cultures, languages, and heritages. Because Britain offers an abundance of historical, archaeological, linguistic, and demographic data on the populations that have occupied the island in the past, it represents a promising area for investigating the impact of such historical events on present-day genetic variation.

As a part of a study characterizing the contemporary genetic makeup of Britain, the paternal genetic contributions of possible source populations to various regions of Britain were studied. We examined Y chromosome variation along an east-west transect across England and Wales, and compared the results with Y chromosome data from Norway and Friesland (a region in the Netherlands). Norway represents one source of the Vikings that settled in Britain, and Friesland represents a possible source of the Anglo-Saxon contribution to the British gene pool because of its geographic proximity to those source populations in the past and because of the linguistic proximity of its language to Old English. DNA samples were collected from males living in seven British market towns located 25-30 miles apart, as well as from Norwegian and Frysian populations. Y chromosome haplotypes were constructed for 612 samples using six microsatellites (DYS19, DYS388, DYS390, DYS391, DYS392, and DYS393) and eleven biallelic polymorphisms (YAP, 92R7, sY81, SRY465, SRY+4064, SRY10831, Tat, M9, M13, M17, and M20).

A distinct cline across Britain was observed, with Scandinavian and northwestern continental European haplotypes present at higher frequencies in eastern England. Interestingly, major differences were also found between geographically proximate towns. These results are consistent with other historical, archaeological, linguistic, and biological evidence of migrations to the British Isles.

Porotic hyperostosis, tetracycline and alcohol use in an ancient population. A. THOMPSON and G. J. ARMELAGOS. Emory University, Atlanta, Georgia 30322

Twenty five years ago, D. Carlson et al. reported on the occurrence of porotic hyperostosis in ancient populations from Sudanese Nubia. In that paper, they discussed multiple etiological factors that might explain the dietary deficiency that caused the anemia that caused the lesion. They discussed the role of diet and parasitic infestation as factors affecting the anemia. In this paper, we report the role that tetracycline and alcohol use may have played in producing anemia. Among the Sudanese Nubian remains, those with porotic hyperostosis have a significantly higher percentage of tetracycline labeled bone ($p < .000$) than those in whom porotic hyperostosis is absent. Known to have a wide variety of antibiotic and non-antibiotic properties, tetracycline appears to affect the uptake of iron from the diet as well. However, alcohol which was the vehicle for the delivery of tetracycline has been shown to affect vitamin bioavailability and may have been a more important factor in producing the anemia. Since tetracycline is also obtained from the diet—most likely from beer and bread—this population presents a uniquely rich opportunity to explore the complex interaction of diet, porotic hyperostosis, and health.

Problems in the identification of female neandertal pelvic remains. A.M. TILLIER and J. BRUZEK, Laboratoire d'Anthropologie des Populations du Passé, Université Bordeaux 1, Talence, France

Within human skeletal samples, the pelvis provides the most significant criteria that allow to establish sexual dimorphism in adults. Among Neandertals this part of the skeleton is not frequently preserved and individuals with a pelvis complete enough to assess the sex are scarce. However, following the published data, it appears that, within this small sample, the number of male individuals is twice the one of females. Besides the unique complete pelvis commonly assigned to the Neandertals which was recovered from the Kebara Cave in Israel (Kebara 2), all the other specimens are represented by incomplete bones and sex assessment is mainly based upon both skeletal robusticity and body size.

One argument usually employed for female sex estimation in recent samples, the elongation of the superior pubic ramus, is claimed to be irrelevant in Neandertals. Another one, the greater sciatic notch, is preferred by scholars and gives a high number of male individuals. But the Kebara 2 male pelvis establishes the fact that a medio-laterally elongation of the superior pubic ramus seems to be morphologically

compensated by the narrowing of the greater sciatic notch. There is indeed, no fossil evidence in support of the accuracy of the pelvic criterion proposed in the literature.

The pelvic morphology could be the reflection of distinct proportions of two morpho-functional aspects in response to new adaptive requirements while the manifestation of the overall sexual dimorphism remains unchanged. While individual variation in morpho-functional aspects of the pelvis is not accurately well documented among adult Neandertals, the aim of this paper is to question the relationships between pelvic morphology and fetal body size, reproductive and locomotion patterns.

Longitudinal bone density data of men: a consideration of rates of change of bone densitometry variables associated with increasing age.

C. R. TILLQUIST and W. A. STINI, Department of Anthropology, University of Arizona, Tucson, AZ 85721

There is a clear trend of decreasing bone density associated with age in men. The concomitant risk of osteopenia and related bone fractures is of growing interest given the changing demographic picture of the United States. The Arizona Bone Density Study has been collecting longitudinal data on bone density of the distal radius since 1982. The results reported here are from a population heterogeneous in terms of lifestyle and socioeconomic status and reasonably generalizable to older men in the United States.

This report presents bone densitometry data for a group of men ($n=195$) followed for at least three scan years past baseline ($\bar{x}=6.23$ years). The age of participants ranges from 45-88 years at baseline to 50-94 years at final scan date. The variables considered in the analyses are baseline and final bone width, bone mineral content (BMC), bone mineral density (BMD), height, weight, and body mass index, as well as estimates of radial cross-sectional area (total, medullary, and cortical) and annualized estimates of change of all bone densitometry and derived variables.

The data reveal decreasing BMD associated with age. This is a trend driven more by decreasing BMC than increasing width. There was little evidence suggesting rates of bone mineral depletion or ratios based on estimates of radial cross-sectional area systematically differ with age. There is, however, increasing variance in the change of BMC associated with age.

In general, the patterns of variation in the data suggest that environmental factors play an increasingly significant role in mediating changes in bone density later in life. Finally, a critical comparison is made between the longitudinal data of the present sample and the larger, cross-sectional population from which it is drawn.

The emergence of modern humans in Africa: evidence from nuclear genetic haplotype data. S.A. TISHKOFF¹, T. JENKINS², G. DESTRO-BISOL³, K.K. KIDD⁴, and A.G. CLARK¹ ¹Inst. of Mol. Evol. Genetics, Dept of Biology, Penn State Univ, University Park, PA 16802 ²Dept. of Human Genetics, S.A.I.M.R., WITS University, South Africa, ³Dept. of Anthro, Univ. "La Sapienza", Rome, Italy, ⁴Dept. of Genetics, Yale University.

The origin of modern humans continues to be a subject of considerable debate despite the accumulation of large amounts of genetic, archeological, and paleontological data. We know little about the population structure, population size, or genetic diversity of archaic humans at the time of emergence of modern human form. Africa has been recognized as a key geographical region for the evolution of modern humans. And yet, Africa has been greatly underrepresented in nuclear genetic studies. As part of a large global study, haplotypes consisting of rapidly evolving microsatellites as well as more stable RFLP and insertion/deletion polymorphisms, have been examined among 13-18 geographically diverse African populations at the CD4, DM, and PLAT loci. Results of this survey indicate very high levels of genetic diversity both within and between African populations. These data suggest that non-African populations originated from a small population(s) in East Africa and that African populations have maintained a large effective population size and a subdivided population structure. The transition from *H. erectus* to *H. sapiens* may have occurred in a highly substructured, and possibly geographically diverse, population in Africa.

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Evaluating models of cultural taphonomy as possible agents of a multiple burial. D.T.O. Arizona State University, Tempe, Arizona 85287-2402

A taphonomic analysis was conducted on a multiple burial that was recovered from a Epi-Classic Mesoamerican site. Several models of cultural and physical taphonomy were generated as possible agents responsible for the deposition of the skeletal remains. This poster focuses on the bioarchaeological techniques used to assess the various possibilities. Each were evaluated based on the interpretations of the laboratory results and archaeological data. Those that did not concur with the data were rejected, while those that remained a possibility were reevaluated for probability.

Nine different possible agents were evaluated. They include models of a natural phenomenon, a primary ossuary, a secondary ossuary, catastrophic deaths, warfare, sacrifice, retainers accompanying an elite burial, cannibalism, and ancestor veneration.

The skeletal deposit contains the remains of at least 29 individuals. It is characterized as a secondary burial of disarticulated human remains that was deposited in one single episode. The skeletal material was placed in a burial pit, with no associated architecture visible. Both

men and women and sub-adults were represented, indicating a normal mortality distribution. Laboratory analyses of the remains indicates that perimortem fracturing, cultural modification, and pathology were not present in significant numbers to indicate a pattern.

The most parsimonious explanation for the multiple burial is that it represents a secondary ossuary of recovered skeletal remains from a local community. The demographic profile of men, women, and children of all ages, the taphonomic factors like poor preservation and carnivore gnawing suggesting some environmental exposure, and the cultural processing of at least two individuals, indicating differential treatment, all suggest patterning that is consistent with the individuals in the multiple burial as having been part of a local community. The secondary nature of this deposit may be due to the decision to recover and rebury those individuals. The skeletal remains may have been inside a crypt or charnel house that was cleared out for reuse, or a move by the local population may have necessitated relocation of the physical remains of the community's ancestral spirits.

Genetics of age related changes in cardiovascular disease risk factors. B. TOWNE, S.S. GUO, W.C. CHUMLEA, A.F. ROCHE, R.M. SIERVOGEL, Wright State U. School of Medicine, Dayton, OH.

Elucidating genetic influences on age related processes in later adulthood is made difficult by the paucity of serial data from relatives who are in or past middle age. In this presentation we use data from the Fels Longitudinal Study to illustrate different statistical genetic approaches to the study of age related changes in body composition and other CVD risks during adulthood. These approaches mirror many of those used to study changes in body size and composition during childhood.

The Fels Longitudinal Study began in 1929 as a growth and development study, and has since evolved to become the longest running study in the world of body composition change over the life span. Soon after it began, the Fels Longitudinal Study became a family study as relatives of original participants were recruited. The oldest participants are 70, and there are presently 363 active participants over the age of 40 representing 111 families. Among these individuals are hundreds of relative pairings, from first degree relative pairs to more distantly related pairs of relatives. These familial data allow estimation of genetic and environmental parameters of age related changes in body composition and other CVD risks.

One initial approach is to estimate the heritability of the extent of change in a trait from a younger age to an older age. When data at two or more ages are available rates of change in traits can be derived, and those rates of change over a span of time can become phenotypes for study. Multivariate methods can simultaneously consider the value of a trait at two or more points in time, as well as the extent of change in the trait. Examples of these approaches using various body composition and other CVD risk phenotypes are presented.

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Lagar Velho 1. E. TRINKAUS, Anthropology, Washington Univ., St. Louis MO 63130, J. ZILHÃO, Instituto Português de Arqueologia, P-1300 Lisboa, C. DUARTE, Instituto Português do Património Arquitectónico, P-1400 Lisboa, T. W. HOLLIDAY, Anthropology, Tulane Univ., New Orleans LA 70118, C.B. RUFF, Cell Biology & Anatomy, Johns Hopkins Univ. Med. School, Baltimore MD 21205.

The 1998-99 discovery of a largely complete skeleton of a ca.4 year old early Upper Paleolithic child at the Abrigo do Lagar Velho, Portugal, adds significantly to our record of Iberian Late Pleistocene hominids and provides the first evidence on the anatomy of the earliest modern humans in Iberia. The child was buried ritually with ochre, pierced shell and cervid teeth in a level that is AMS dated to ca.24,500 BP. The minimal associated archeological remains suggests use of the site primarily for mortuary purposes.

The skeleton preserves the axial skeleton, most of the limb bones with many epiphyses (the left shoulder and arm, the pelvis, both legs, major portions of the hands and feet), 2/3 of the mandible, temporal bones, multiple neurocranial fragments including the periorbital region, ≥ 13 primary teeth, and ≥ 20 secondary teeth. The only pathological lesions are minor enamel hypoplasia, tibial and metatarsal transverse lines and trauma to the lateral mid-radius. In conjunction with developmentally plastic appendicular epiphyses, there is nothing to indicate developmental abnormalities.

Current analysis of the specimen indicates that within most of the major anatomical units, and in the context of developmentally appropriate comparisons, the morphological pattern has clear derived European early modern human features combined with either archaic *Homo* or regionally specifically Neandertal elements. This is apparent through discrete trait observations and proportional morphometrics and is evident within and across the neurocranium, the facial skeleton, the dentition, and the limb remains. These observations are consistent with an hypothesis of admixture between late Iberian Neandertal populations and European early modern humans dispersing into Iberia after 30,000 BP.

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Nomads of Mongolia: Y chromosome perspective.

D. TUMEN, Dept. of Anthropology and Archaeology, National University of Mongolia, Ulaanbaatar-46, Mongolia T.M KARAFET, University of Arizona, Tucson, AZ 85721, and Institute of Cytology and Genetics, Novosibirsk, 630090, Russia, and M.F. HAMMER, University of Arizona, Tucson, AZ, 85721

Contemporary Mongolia is inhabited by more than 20 ethnic populations speaking the languages of Mongolian and Turkic branches of the Altaic linguistic family. Archeological data indicate that Mongolia was inhabited some 100,000 years ago, and studies of prehistoric skeletal samples revealed significant heterogeneity among different geographic areas of

Mongolia. However classical markers and mtDNA showed low levels of genetic differentiation of Mongolian populations.

This study represents the first Y chromosome survey of different ethnic groups of Mongolia. We used 20 biallelic Y chromosome markers to study affinities among 12 ethnic groups in Mongolia and their paternal relationships to other world populations. Our Mongolian sample consisted of 370 males from 9 groups of West Mongolia and 3 groups of North, Central and East regions.

Although the combination of variation at the biallelic polymorphic sites resulted in thirteen haplotypes in Mongolia, two of the haplotypes, 1F and 1U, accounted for 78% of the samples. The overall F_{st} value was 0.053 ($P < 0.01$). Surprisingly, this value is eleven times smaller than the F_{st} for Siberian populations of hunter-gatherers. We did not find significant genetic variation among four geographic groups in Mongolia ($F_{st}=0.007$; $P=0.20$). However, two linguistic subdivisions (Mongolian and Turkic) reached significant differentiation ($F_{st}=0.031$; $P < 0.05$). The results are consistent with hypothesis of the relatively recent ethnic differentiation of Mongolian groups. The lifestyle of Mongolian nomads may have provided high gene flow that prevented genetic isolation of populations.

This study was supported by NSF grants OPP-9806759 to MFH.

Genetics and morphology in vervet monkey evolution.

T.R.TURNER, J.P.GRAY, F. ANAPOL, University of Wisconsin-Milwaukee, Milwaukee, WI 53201 and M.L. WEISS, National Science Foundation, Arlington, VA 22230.

An examination of local and regional groupings of organisms can provide insights into microevolutionary processes, including migration, adaptation, drift and local differentiation. For the past several years, we have been engaged in an examination of these microevolutionary processes in several populations of vervet monkeys (*Cercopithecus aethiops*). We have used variation in genetic, morphometric, behavioral and endocrine data to accomplish this goal.

Vervets are broadly distributed in Africa, both geographically and ecologically. Like other Old World monkeys, they are long-lived and slow-breeding. We collected samples for genetic analysis from over 360 animals living at four sites in Kenya separated by up to 300 km. The sites differ from each other in temperature, altitude and mean annual rainfall. We have examined allelic data from ABO-like blood groups, 30 allozyme and serum protein loci and 12 STR loci in an attempt to elucidate the genetic structure of these populations. While only a third of the STR loci are polymorphic, these loci exhibit considerable heterozygosity and sites can be distinguished from each other by pattern of allele frequencies. Most alleles are found at all sites, but allele frequencies vary significantly from site to site. Techniques

such as quadratic assignment, assignment index and bootstrapping delineate the clustering patterns of local sites. Even though allele frequencies differ, no one site can be clearly differentiated from all the other sites.

We also collected morphometric measurements on these same animals. An analysis of these measurements indicate considerable variation and differentiation in female size and in tail length between sites. This differentiation in populations by morphology and the lack of clear differentiation in genetic loci may provide a unique test case for the utility of non-human primates as models for human evolution.

This work was supported by NSF grant BNS88-18405.

Detection of baboon endogenous virus (BaEV) in a natural population of anubis and hamadryas baboons. MONICA UDDIN, Department of Anthropology, New York University/NYCEP, New York, NY 10003. U.S.A.

The complete baboon endogenous virus (BaEV) spans 8507 nucleotides and contains the *gag*, *pol*, and *env* open reading frames characteristic of all retroviruses. As an endogenized retrovirus, BaEV is believed to persist in a stably integrated, vertically transmitted form within the baboon genome, with estimates of germ line colonization currently placed between 24 to 500 kya (van der Kuyl *et al.* 1995. *J. Virol.* 69:7877-7887). Although BaEV can be detected in the genomes of many other cercopithecines, its distribution does not follow known host phylogeny and is not consistent with a pattern of inheritance from a common cercopithecine ancestor, suggesting multiple instances of cross-species transmission and germ-line fixation.

Here I report on the first effort to assess the distribution of BaEV across a free-ranging, natural population of baboons (*Papio hamadryas hamadryas* and *P.h. anubis*) sampled from a hybrid zone in Ethiopia. Amplification of BaEV-specific *env* and LTR fragments was undertaken to detect the presence or absence of BaEV in a representative sample of individuals (N=21) with previously determined degrees of hybrid ancestry. Preliminary data indicate that BaEV is widespread across the hybrid zone, occurring in baboons with high degrees of anubis, hamadryas, and hybrid ancestry. These findings confirm the presence of BaEV in this feral baboon population and present a pattern consistent with the hypothesis of long-term vertical transmission.

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Secular trend in birthweight among the Purari delta population, Papua New Guinea. STANLEY ULIJASZEK. Institute of Biological Anthropology, University of Oxford, UK.

Papua New Guinea is a country undergoing rapid modernisation. With this has come a secular trend towards increased adult body size in some parts of the country but not others (Ulijaszek, 1993). Birthweight data, collected by month of delivery at Kapuna Hospital in the Purari delta of Papua New Guinea between the years 1969 and 1996, was analysed by year of birth and by season, to determine the extent of any secular trend in birthweight, and seasonality of birthweight. A total of 927 birthweights were included in the analysis. There is clear evidence of a secular trend in increasing mean birthweight between across the period 1969 to 1996, with the largest significant difference being between 1977 and 1994, from 2.70 to 2.92kg. The rate of birthweight increase between 1977 and 1994 was 130g/decade, lower than the gain of 200g/decade across the period 1994 to 1996. The proportion of infants born of low birth weight (<2.5kg) shows a slight increase between 1969 and 1972, and a decline thereafter. While seasonal differences in birthweight during any of the years examined is non-significant, significantly greater mean birthweight across the period 1969 to 1996 was found for births during the wet season (April to July), and the drier season (August to November) respectively. The seasonality of secular trend in mean birthweight among the Purari delta population may be a function of seasonally-varied displacement of traditional diet by non-local bought foods, as well as reduced seasonality of maternal workload associated with the processing of the traditional staple food.

ULIJASZEK, S.J., 1993, Evidence for a secular trend in heights and weights of adults in Papua New Guinea. *Annals of Human Biology*, 20, 349-55.

Paleodietary survey of the Portuguese Mesolithic-Neolithic transition. Trace element analysis using INAA technique. C. UMBELINO, Departamento de Antropologia, Universidade de Coimbra, 3000-056 Coimbra, Portugal.

The Mesolithic-Neolithic transition is one of the major phases in the human career. This period is particularly well portrayed in Portugal due to the large Mesolithic

skeletal collections of Muge and Sado shell middens, besides several Neolithic ones. In this paper it is our purpose to characterize these past populations in a paleodietary perspective, through trace element analysis. Approximately one hundred human bone samples coming from six Neolithic sites and sixty from the Mesolithic ones are examined. Using INAA technique (instrumental neutron activation analysis), performed at the Nuclear and Technologic Institute (ITN) at Lisbon, more than 50 bone element concentrations are ascertained. The human bone samples removed from the femur shafts (compact tissue) are submitted to short and long irradiations with thermal neutron flux of the nuclear reactor. The similarities and differences in bone trace elements contents from the different sites are presented and the importance of the different elements in dietary inferences is discussed.

Age estimation at Tirup Cemetery: An application of the transition analysis method. B.M. USHER, Department of Anthropology, Pennsylvania State University, University Park, PA 16802; J.L. BOLDSSEN, Anthropological Database, Odense University, Odense, Denmark; and D. HOLMAN, Department of Anthropology, University of Washington, Seattle, WA 98195

Estimating age-at-death from skeletal material is one of the most difficult tasks facing physical anthropologists, and simultaneously one of the most important. Paleodemographers, paleopathologists, forensic anthropologists, and other skeletal biologists base many of their results on the age of a single skeleton, or the age-at-death structure of an entire population. However, many of the formal methods available are both biased and unreliable. In this paper we present an application of the new transition analysis method (Milner, Boldsen, and Usher, 1997), which offers unbiased age estimation for adult skeletons. This method uses a staged scoring procedure on features of the pelvis and skull. The results are presented as a maximum likelihood curve, with a "most likely" age and a 95% confidence interval. We propose that the age-at-death is best understood by using all the information from the curve.

The first use of this procedure on an archaeological population is presented here. Tirup is an early Medieval Danish site on the east coast of Jutland, and consists of the remains of two churches (one replacing the other) and the associated cemetery. The site was completely excavated, and the remains of more than 600 individuals were recovered. Half were children under the age of fifteen. The skeletal remains were examined during the 1997-98 academic year at the Anthropological Database,

Odense University, by the first author. Over half of the adult skeletons (about 157) had at least one feature that could be scored using transition analysis. The results are impressive. Even a single scored trait contains information about age, even if the confidence interval is very wide. The age-at-death estimates are used to create a rough survival curve for the adult population. The males and females appear to have different mortality patterns, with the females dying younger than males, on average.

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Interproximal grooving of fossil hominin teeth: additional evidence from Olduvai Gorge. P. S. UNGAR, University of Arkansas, Fayetteville, AR 72701, F.E. GRINE, State University of New York, Stony Brook, NY 11794, M.F. TEAFORD, Johns Hopkins University, Baltimore, MD 21205, A. PÉREZ-PÉREZ, Universitat de Barcelona, Spain and C.C.MAGORI, University of Dar es Salaam, Tanzania.

Interproximal tooth grooves have been documented in prehistoric samples of *Homo sapiens*. Most authors agree that these grooves derive from palliative tooth-picking. Interproximal grooves have been observed in a number of *H. neanderthalensis* and *H. heidelbergensis* dentitions, and in one specimen each of *H. erectus* (Zhoukoudian, China), and *H. habilis* (Member G, Shungura Formation, Ethiopia).

OH 60 is a moderately worn RM₃ found on the surface of Bed I, Olduvai Gorge. It has been attributed to *Paranthropus boisei* by Day (1986). The mesial surface of the root has a very shallow, nearly horizontal furrow immediately apical of the mesial cervical margin that is slightly broader lingually than buccally. Its floor exhibits a number of fine, parallel striae. The size, morphology and location of this interproximal groove are consistent with its having been created by palliative tooth picking.

The OH 60 crown (MD 14.0; BL 11.2) is notably smaller than any other *P. boisei* homologue, and its dimensions fall well below the corresponding *P. boisei* and *H. habilis* sample means. On the other hand, the OH 60 values fall within the observed sample ranges of East African *H. erectus*. On the basis of its crown size, therefore, attribution of OH 60 to *P. boisei* is clearly unwarranted, and it more likely represents *H. erectus* than *H. habilis*.

While interproximal toothpick grooves have been identified in even small early *Homo* samples, they have not been observed in other hominin genera, despite the large samples available for some of these taxa. To our knowledge, tooth-picking has not been described in any of the extant great apes, even though over a dozen behaviors that involve the use of a stick (including clearing the nasal passage!) have been documented in chimpanzees. It is tempting to speculate that tooth-picking may be a behavior peculiar to *Homo*, and that it may be related to a diet that involved different items even in the earliest members of this genus.

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Females control male reproductive success in wedge-capped capuchins, based on genetic and behavioral data. X. VALDERRAMA¹, J.G. ROBINSON², and D.J. MELNICK^{1,3}.

¹Department of Anthropology, Columbia University, New York, NY 10027, ²Wildlife Conservation Society, 2300 Southern Blvd., Bronx, NY 10460, and ³Center for Environmental Research & Conservation, Columbia University, New York, NY 10027.

Genetic analyses were combined with field observations of wedge-capped capuchin monkeys (*Cebus olivaceus*) to examine the role of each sex in the two major components of reproductive success: breeding activity and offspring survivorship. Twenty-one years of behavioral observations previously have indicated that fertile females control the breeding system by soliciting and mating only with the group's alpha male. Incorporating noninvasive genotyping using hairs from wild capuchins now lends support to these observations. Twelve autosomal nuclear microsatellite loci and the mitochondrial D-loop were analyzed for two habituated groups in the llanos of Venezuela. Such a skewed distribution of male reproductive success increases the degree of intragroup relatedness and decreases effective population size relative to other breeding systems.

Female wedge-capped capuchins also control group size and structure through matrilineal fission and group fusion. In this way, females as well as males distribute genetic material across groups. Genetic analysis of matrilineal structure shows congruence with social structure. This result, combined with increased relatedness as a result of unimale breeding, lends support to the potential for nepotism among females related within matrilines. In particular, allomaternal care may enhance offspring survivorship and hence indirect reproductive success. In conclusion, wedge-capped capuchins successfully use social mechanisms to enhance reproductive success. This research was supported by National Science Foundation grant 9908455 and the Wildlife Conservation Society.

Directional asymmetry in plagiocephaly without synostosis and unicoronal synostosis. C.J. VALERI, T.M. COLE III, S. LELE, J.T. RICHTSMEIER, The Johns Hopkins University School of Medicine, Baltimore, University of Missouri, Kansas City, University of Alberta, Edmonton.

Plagiocephaly without synostosis (PWS) and unicoronal synostosis (UCS) show similar cranial deformations that are usually identified as right or left frontal flattening and contralateral posterior flattening. Fusion of the coronal suture alters forces within the neurocranium during growth and affects the basicranium as well. In PWS, investigators speculate that sleeping position or cranial molding during birth causes cranial asymmetry. The purpose of this study is to compare the directional asymmetries of the cranium in UCS and PWS and to determine their differential effect on the basicranium.

Twenty-six landmarks on and around the

basicranium were collected from three-dimensional reconstructions of computed tomography scans of patients diagnosed with plagiocephaly at the Johns Hopkins Hospital. Magnitudes of global and local directional asymmetry were calculated using Euclidean Distance Matrix Analysis (EDMA).

In UCS, asymmetry was localized to anteroposterior distances local to the lateral edge of the cranium. Relative to the unfused side, the fused side was shorter along the anteroposterior axis. Directional asymmetry in the PWS sample was localized to mediolaterally oriented distances measured from the midline to lateral points on the affected side, while distances that crossed the anterior cranial base were reduced on the unaffected side.

Fusion of the coronal suture reduces growth in the anteroposterior direction on the affected side. The contralateral side compensates by growing at a faster rate in the same direction. In PWS, asymmetry in the mediolateral distances demonstrates that the skull is compensating for deformation of the affected side by expanding mediolaterally on the unaffected side.

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Coevolution of humans and their viruses.

L. M. VAN BLERKOM, Anthropology, Drew University, Madison, NJ 07940

Infectious disease agents and their metazoan hosts evolved together as each adapted to changes in the other's virulence or resistance, respectively, and to fluctuations in the larger ecosystem. This coevolutionary relationship is especially apparent with the viruses, whose use of host intracellular machinery for replication renders them more species-specific than other pathogens. Nucleic acid sequencing now provides a tool for studying the evolutionary history of both viruses and their hosts. The DNA or RNA sequences of many viruses have been deciphered, along with their phylogenetic relationships, both among the types that infect humans and with other animal viruses.

Comparison of viral and human molecular phylogenies illustrates how some viral families (e.g., adenovirus and herpesvirus) coevolved with the primates and adapted to the point of producing latent or inapparent infections in their hosts, while others (especially RNA viruses such as the ortho- and paramyxoviridae) entered the hominid line at a later time and remain more virulent. Not all ancient viruses have attenuated, however, especially when host range is broad and virulence does not interfere with transmission (e.g., yellow fever).

More recent human migrations can be traced in the diversification of viruses such as the papillomaviruses and hepatitis B. The phylogenies of some of the zoonoses (diseases of other animals that

can also infect humans) suggest that animal viruses (e.g., rabies) spread out of Africa and the Mideast along with migrating fauna (including modern humans) and could have been a factor in the evolutionary competition between contemporaneous hominid species.

Sex differences in tool use and meat eating among wild orangutans. CAREL P. VAN SCHAİK, Duke University, Dept. of Biological Anthropology and Anatomy, Box 90383, Room 08 Bio. Sci. Bldg., Science Dr., Durham, NC 27708.

Tool use among great apes may provide us with a window into the tool use among *Australopithecus* and perhaps early *Homo*. The first stone tools suggest a role in meat processing, implicating males as major tool users. However, findings on chimpanzees have generated the opposite sex bias in tool use. New data on orangutan tool use are presented here from a population in which tools are used to extract seeds from protected fruits (during relatively brief but intensive periods) and to extract social insects or their products from tree holes (on a more regular but less intensive basis). The orangutan data are analyzed for sex differences in rate of tool use in the two main contexts, and in the efficiency of use in the treehole context, as well as in rates of tool use per unit foraging time. A similar sex difference as in chimpanzees emerges. Meat eating, while rare, also shows a female bias in orangutans. To explain this pattern of variation, I examine underlying sex differences in foraging styles and, more broadly, in foraging and ranging strategies. Strategic sex differences also explain variation in sex differences in meat eating.

Human genetic loss of CMP-sialic acid hydroxylase occurred after the last common ancestor with the great apes. A. VARKI, Glycobiology Research and Training Center, University of California, San Diego, La Jolla, CA 92093.

The surface of all living cells is covered with a dense and complex array of sugar chains that serve to mediate many biological roles, particularly interactions between different cell types. In higher animal cells, a type of sugar called sialic acid frequently occupies the outermost position on the cell surface. The sialic acids

are actually a family of closely related sugars arising from structural variations of the parent molecule N-acetyl-neuraminic acid (Neu5Ac). One common variation called N-glycolyl-neuraminic acid (Neu5Gc) is generated by adding a single oxygen atom to Neu5Ac. We have found that while Neu5Gc is hard to detect in human body fluids, cultured cell lines and tissues, it is a major component in corresponding samples from all four extant great apes, as well as in other mammals. An exception is the brain, where levels of Neu5Gc are very low in all mammals. The conversion of Neu5Ac to Neu5Gc is mediated by a specific hydroxylase enzyme that converts the activated sugar nucleotide CMP-Neu5Ac to CMP-Neu5Gc. We found that this enzyme activity is detectable in chimpanzee cells, but not in human cells, thus explaining the rarity of Neu5Gc in humans. The genetic basis for this difference was found by showing that while the hydroxylase cDNA from the chimpanzee is similar to that of other mammals, the human cDNA contains a 92bp deletion, due to the loss of a single exon. This results in a frame-shift mutation that can explain the lack of enzyme activity in humans. Genomic PCR analysis indicates that the mutation occurred sometime after the divergence of hominids from the great apes (~5-7 million years BP), but before the common origin of all modern humans (probably ~0.2-0.5 million years BP). In this presentation, I will update our ongoing work on this topic, which includes:

1. Analysis of Neu5Gc content in Pleistocene fossils of mammals and hominids with a view to understanding the timing of occurrence of the mutation;
2. Exploration of the traces of Neu5Gc that is found in some human tissues and tumors;
3. Studies of the consequences of human Neu5Gc loss on recognition by sialic acid-binding proteins;
4. Attempts at transgenic overexpression of Neu5Gc in mice, particularly in the brain; and,
5. Use of metabolic precursors to convert human cells into Neu5Gc expressors.

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Plant species composition of diet in two sympatric lemurs: *Varecia variegata rubra* and *Eulemur fulvus albifrons*. N. VASEY, Anthropology Department, Pennsylvania State University, University Park, PA 16802.

Varecia variegata rubra and *Eulemur fulvus albifrons* are both largely frugivorous (88% and 69% respectively), yet food patch distribution and ranging patterns differ between these two lemur taxa (Vasey, 1997). Food patches of *V. v. rubra* are further apart. *Varecia* females, in particular, show marked seasonal fluctuations in the spatial distribution of food patches and in daily distances traveled, whereas *E. f. albifrons* shows few seasonal fluctuations. These patterns are attributed to different foraging and reproductive strategies. This study documents longitudinal patterns of plant species utilization and demonstrates how such patterns contribute to taxon-specific patterns of food patch distribution and ranging. Plant species composition of diet was determined by collection and taxonomic identification of all plant foods consumed by each lemur species during a yearlong field study on the Masoala Peninsula, Madagascar. For examining longitudinal patterns, instantaneous time point

samples on focal animals are analyzed by month and by season. I also compare the number of food items fed on daily by each species. *V. v. rubra* and *E. f. albifrons* share many plant species in common. Like many other frugivorous primates, the bulk of their diets are composed of a small percentage of the total number of plant species consumed. Plant species used heavily by one lemur species in a given month are rarely used in similar proportions by the other lemur species. During many months of the year, *E. f. albifrons* feeds on more food items daily. *E. f. albifrons* also relies heavily on certain plant species that are available over long periods of time. Conversely, *V. v. rubra* relies on plant species that are depleted more rapidly. Thus, the diet of *E. f. albifrons* is more diverse on a short-term basis, whereas the diet of *V. v. rubra* is more diverse on a long-term basis. Certain plant species used by *V. v. rubra* markedly increase home range size and daily distances traveled, yet contribute little (< 1%) to the overall feeding budget. Many aspects of food plant usage contribute to niche separation in this diurnal lemur community.

Sex differences in Balinese macaque (*Macaca fascicularis*) temple-licking: Requirements of lactation versus a taste for salt? S. M. VELLUCCI¹, A. FUENTES¹, K. G. SUARYANA², AND I. D. K. HARYA PUTRA², ¹Department of Anthropology, Central Washington University, WA 98926 and ²Primate Research Center at Universitas Udayana, Bali, Indonesia

Recent studies suggest that geophagy aids in the supplementation of primates' diets. Temple licking, a behavior similar to geophagy, also occurs in various primate species, presumably for analogous reasons. Wheatley (1989) found that female long-tailed macaques (*Macaca fascicularis*) temple-licked more frequently and for longer duration than juveniles and adult males. He suggested that macaques temple-licked in order to obtain elements leached from the stone medium, specifically sodium chloride. It has been suggested that lactating females temple-lick to replenish nutrients and minerals depleted during the process of lactation. We conducted the present study to assess whether lactating females temple-lick more frequently and for longer duration than non-lactating females and males.

Data were collected at Padangtegal monkey forest in Bali, Indonesia during June and July of 1999. Observations were made on three subject groups of long-tailed macaques: lactating females (n=23), non-lactating females (n=36), and adult males (n=12). All-occurrence focal sampling of the entire population was used to record temple-licking bouts. Samples of the stone medium were analyzed for content by the Geology and Chemistry Departments of Central Washington University. Chi-square goodness of fit test results indicate no significant difference in frequency of temple-licking between the three subject

groups. However, lactating females were found to temple-lick significantly longer than the other two subject groups (X^2 [df=2]=59.03, $p<0.005$).

Comparison of the amount of mechanical loading between humans and quadrupeds using intracortical remodeling rates of the humerus, femur, and rib. M. T. VENNEMEYER. Anthropology, University of Missouri-Columbia, 65211.

One of the primary functions of bone tissue is mechanical support. Through bone modeling and remodeling, bones are able to adapt to their typical biomechanical demands. Observed intraskeletal variation in histomorphometry is a result of the unique loading history of each skeletal element. Different locomotor and behavior patterns among species must be reflected in their intraskeletal variation in histomorphometry. In an earlier study, Robling (1998) demonstrated histomorphometric differences between the human femur and rib, and reports that a significant amount of the observed variation can be explained by different loading demands between these two bones. Species exhibiting different patterns of locomotion, therefore, must exhibit different patterns of intraskeletal variability. An analysis of histomorphometric intraskeletal variability of several species varying in mode of locomotion was undertaken. Samples from the rib, femur and humerus from 8 (each) human, macaque, pig, dog, and deer skeletons were obtained. Histological sections from the midshaft were prepared, and osteon population density (OPD) was calculated. OPD for the humerus and femur of each species were regressed on their respective rib OPDs, and the resulting residuals used as a measure of the relative amount of their OPD due to biomechanical differences, i.e., not explained by the rib. Although based upon a limited sample, these results indicate differences in the patterns of intraskeletal variation in OPD among the rib, humerus and femur. These differences reflect biomechanical variation related to locomotion. Additional research is underway to expand the sample sizes and include a greater variety of species.

The ontogeny of the modern human facial skeleton: how do geographically distinct facial shapes develop? U.STRAND VIÐARSDÓTTIR, University of Durham, DH1 3HN, UK, P.O'HIGGINS, University College London, WC1E 6JJ, UK

The morphology of the adult facial skeleton is one of the most reliable indicators of 'racial' affinity in

modern humans. However, little is known about the comparative post-natal development of this anatomical region between modern human groups. This study compares facial morphology and growth in 10 modern human populations, to assess the degree to which population specific morphologies are established early and the degree to which diverse growth patterns underpin the diversity of modern human adult facial forms. In order to do so 26 landmarks are taken from one half of the facial skeleton in a total of 334 individuals at all stages of post-natal development. The landmarks are then analysed using geometric morphometric techniques.

The analytical techniques allow population specific growth vectors to be identified. It is found that some of the differences in adult facial shapes between populations result from significant differences in growth vectors. In addition to this finding, all the populations can be significantly separated on the basis of some aspect of facial shape, irrespective of age and sex, indicating that population specific morphologies are to some degree established early in development. The relative relationships between combined subadult and adult representatives of diverse populations are further examined in terms of the Mahalanobis' distance matrix, and discriminant analysis and are found to be closely correlated with relationships obtained from a sample of adults only.

The results of this study indicate that geographically distinct modern human facial shapes develop through two processes. First, all populations develop distinctive facial shapes early, possibly pre-natally. Second, some populations grow their facial skeletons along divergent vectors.

Bipedality in chimpanzees (*Pan troglodytes*) and bonobos (*Pan paniscus*): testing hypothesized selection pressures. E. N. VIDEAN¹ and W. C. MCGREW², ¹ Zoology, ² Anthropology, Miami University, Oxford OH 45056

Study of the evolution of bipedalism has evoked many hypotheses regarding its origin. Observational data on positional behavior of captive chimpanzees (*Pan troglodytes*) and bonobos (*Pan paniscus*) were used to test specific hypothesized selection pressures, i.e. carrying objects, postural foraging, vigilance, and agonistic displays, that may have been important in the transition from quadrupedalism to bipedalism. The subjects included nine bonobos housed at the Columbus Zoo in Columbus Ohio and 14 chimpanzees housed at the University of Texas MD Anderson Science Park in Bastrop Texas.

In control sessions, there were no overall species differences in the rates of bipedalism. However, species differences in the behavioral contexts of bipedalism were found. Overall, vigilance was the most frequent context for bonobo and chimpanzee bipedalism. Locomotor bipedalism in bonobos displayed higher rates of vigilance contexts than seen in chimpanzees. Postural bipedalism in chimpanzees showed higher rates of feeding related contexts when compared to bonobos. The introduction of

large food objects (carrying hypothesis) resulted in increased rates of unassisted bipedalism in both species and increased rates of locomotor bipedalism in bonobos. The introduction of display objects (display hypothesis) resulted in increased rates of unassisted bipedalism in chimpanzees only. The construction of visual barriers (vigilance hypothesis) did not result in any noticeable changes in the rates of bipedalism in either species. Finally, the introduction of raised feeding structures to chimpanzees (foraging hypothesis) resulted in higher rates of both assisted and postural bipedalism. These findings indicate that the contexts of spontaneous bipedalism in *Pan* species are varied, but that there is no consistent interaction of species and context.

Comparative functional morphology of the mandibular condyle between anthropoid and strepsirrhine clades. C.J. VINYARD, Department of Biological Anthropology and Anatomy, Duke University, Durham, NC 27710.

Compared to strepsirrhines, the anthropoid primate clade is characterized by relatively larger mandibular corpora and symphyses. Anthropoids also possess fused mandibular symphyses and relatively robust and vertically-implanted incisors versus the typically unfused symphyses and procumbent tooth combs of strepsirrhines. Each of these features suggests that anthropoid jaws can withstand relatively larger loads during mastication and incision. These observed morphological differences between the two clades, coupled with *in vivo* data for muscle-activity patterns and behavioral use of the incisors, collectively support the hypothesis that anthropoids routinely resist relatively larger loads than strepsirrhines during the power stroke of mastication and/or incision.

Static mechanics and *in vivo* strain data of macaques chewing indicate that the primate temporomandibular joint (TMJ) experiences considerable reaction forces during the power stroke of mastication and incision. Differences in TMJ form between anthropoids and strepsirrhines have not been quantified despite the joint's load bearing function. This analysis further tests the hypothesis that anthropoids withstand relatively larger masticatory loads than strepsirrhines during mastication and/or incision by assessing the prediction that anthropoids should have relatively larger condyles than strepsirrhines. Only the condyle is examined as it is likely to be more closely tied to a load bearing function.

Condyle lengths (AP), widths (ML) and areas were measured in 43 anthropoid and 53 strepsirrhine species using a 3D Reflex microscope. Condyle measures for anthropoid versus strepsirrhine species means were compared via ANCOVA for least squares as well as Clarke's Test and Tsutakawa and Hewett's test for reduced major axis regressions ($\alpha=0.05$). Mandible length served as a cranial size estimate in regressions.

Anthropoid condyle areas are significantly transposed above strepsirrhines at similar jaw lengths, although the two clades share similar slopes. Anthropoids also have ML wider condyles than strepsirrhines at a given jaw length, notably in the medial part of the condyle. The relatively larger anthropoid condyle is at least in part due to their increasing relative ML width as compared to strepsirrhines.

The relatively larger and wider condyle of anthropoids supports the hypothesis that anthropoids experience increased loads in the jaw as compared to strepsirrhines during the power stroke of mastication and/or incision.

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The relationship between body size and postcranial variation in hominoids and several monkeys. P.S. VINYARD, Department of Anthropology, Washington University, St. Louis, MO 63130-4899.

It has long been hypothesized that body size and variation are associated interspecifically, with larger species having relatively greater variation than smaller species. While many studies suggest that increasing body size is related to greater postcranial variation, this relationship has not been widely empirically documented in primate postcrania with large intraspecific sample sizes capable of accurately estimating variation in a dimension.

This research addresses the interspecific association between body size and postcranial variation by testing the prediction that body size is positively correlated with postcranial variation across *Cebus apella* (n=86), *Macaca fascicularis* (61), *Colobus badius* (47), *Hylobates lar lar* (104), *Pongo pygmaeus* (57), *Pan paniscus* (31), *Pan troglodytes troglodytes* (126), *Gorilla gorilla gorilla* (142) and *Homo sapiens* (103). Variation was quantified through the variance and the coefficient of variation (CV) for 97 measurements taken on the humerus, radius, ulna, femur and tibia. Measures of dispersion were compared to a body size estimate, a geometric mean (GM) constructed for each bone, using both Spearman's r_s and Kendall's τ correlation coefficients ($\alpha=0.05$) across species. Separate male and female estimates of variation were used to increase sample size and eliminate the confounding problem of sexual variance dimorphism.

The variances for all postcranial dimensions were significantly positively correlated with the GM across species. Only 5 measures showed significant correlations between the CV and GM across species. This suggests the CV generally gives a reasonable estimate of relative variation. However, significant correlations between the GM and these 5 measures, each localized to the forearm, implies that the CV can be correlated with size in certain instances. Size-related changes in these CVs may be tied to allometric changes among these variables that affect these measures of dispersion. Further correlations will be conducted between multi-variable CVs and the GM.

Size-related increases in a dimension's variance may impact the selection intensity and response to selection in populations such that evolutionary rates may differ in taxa of different body sizes. For example, size-related increases in the variance for a dimension may lessen the selection intensity on that measure in large versus small taxa when holding the selection differential constant.

This research was supported by grants from the L.S.B. Leakey Foundation, Sigma Xi and the AMNH.

Prospective Longitudinal Study of Menstrual Patterns in an Agropastoral Aymara Population. V.J. VITZTHUM, Anthropology, SUNY at Binghamton, NY 13901, USA; H. SPIELVOGEL and E. CACERES, Instituto Boliviano de Biología de Altura, La Paz, Bolivia.

Although menses is an indicator of a woman's reproductive capacity, remarkably little is known of species-wide natural variation in menstrual patterns. Whereas modern contracepting women generally spend the majority of their reproductive years in repeated cycling, throughout human evolution women experienced extended cycles of amenorrhea during pregnancy and lactation and, for some, menses while still breastfeeding. Recognition of the dramatic and recent shift in reproductive patterns has prompted inquiries into variation in menstruation among women in non-

industrialized populations, among whom the historical pattern of amenorrhea and menstrual cycling remains evident, both to model the evolution of the human reproductive system and to ascertain the potential health implications of increased repeated cycling.

REPA (Reproduction and Ecology in Provincia Aroma) is a longitudinal study of reproductive function and health among rural Bolivian Aymara. Subsistence is principally agropastoralism augmented by varying participation in a market economy. Representing more than 80% of the non-contracepting married women aged 20-40 years in 30 altiplano communities, study participants (n=316) were classified according to reproductive status (lactating and/or menstruating) at recruitment and followed longitudinally for up to 18 months; conceptions were detected with urine tests for hCG and observed till loss or birth. From 1 to 7 non-truncated menstrual cycles each (including duration of menses) were recorded for 156 women for a total of 614 cycles. Additional data include reproductive histories, anthropometrics, hemoglobin, 24-hour dietary recall, heart rate monitoring and measures of respiratory function and work capacity, infant feeding practices including recorded breastfeeding frequency, and socioeconomic indicators. These data are used to evaluate intra- and inter-woman variation in menstruation, and test hypotheses regarding the relationships of menstrual cycle and menses durations, and fecundity, with nutritional status, physical activity, and infant feeding practices. Supported by NSF SBR-9506107.

Skeletal indications of proto-urban life on the central coast of Perú. J.A. VRADENBURG, University of Missouri-Columbia, Columbia, MO 65211

Archaeological interpretations often assume that the overall quality of life in the urban centers of state-level societies was lower than in the dispersed settlements of less complex societies. On the central coast of Perú, proto-urbanism, and possibly complex chiefdoms, characterized the early part of the Early Intermediate Period (EIP) (200 B.C. - 600 A.D.), while true urbanism and state-level society, as embodied in the Lima State, characterized the middle to late EIP. Data were obtained from two skeletal series, the earlier Villa el Salvador [VeS] and the later El Necropolis de Tablada de Lurin [TdL], which are assumed to represent an early stage of urbanism. This paper outlines social changes that can be inferred from skeletal data which might reasonably be expected to accompany the development of urbanism. Compared to interpretations based on earlier skeletal series, VeS and TdL exhibit demographic parameters and age/sex-specific patterns of skeletal pathologies suggesting changing socio-economic behaviors. These patterns include: 1) agricultural reliance preceding urbanism; 2) increased childhood stress, especially for males; 3) mixed indications for adolescent and adult general health, which may have decreased for males; and

4) the appearance of warfare. Additionally, by the early EIP, a probable non-venereal treponematosi had become attenuated to the pre-urbanism of the Central Coast, resulting in endemicity and increased chronicity of individual infection., leading to an increase in survivorship after age 40. These findings suggest that some of the assumed patterns of behavior and health associated with true urbanism and, by extension, state-level society, preceded both. Proto-urbanism and associated socio-economic behaviors increased many health risks, however, the level of general health stabilized and, in some aspects, improved.

Bone Histomorphometric Correlates of Biomechanics, Limb Use Patterns, and Bone Function. R.A. WALKER and T.M. GREINER, Dept. of Anatomy, New York Chiropractic College, Seneca Falls, NY 13148-0800.

Skeletal histomorphology is a reflection of remodeling in response to imposed mechanical loads. As a consequence, some of the history of an animal's activities and the specific functions of bones within the skeleton are reflected in the microstructure of its bones. For the last several years, activities in our laboratory have focused upon quantifying intraindividual variation in the long bones of various vertebrate species. We have sectioned left and right femora, tibiae, humeri, radii and ulnae transversely at intervals of 10 % of the bone's total length in cat and chicken. We have extended this work to selected human and nonhuman primate species as well. Research conducted thus far has concentrated on examination of variation in cross-sectional geometrical properties and haversian morphology. Quantitative analysis of haversian structures have been between proximal and distal limb segments, between serially homologous fore and hind limb bones, between contralateral members of pairs of bones, and proximodistally within bones. These parameters are found to be asymmetric between left and right sides in *Felis* and *Homo*, though not so in *Gallus*. The asymmetry of the mammalian fore limb, particularly in the ulna, suggests that remodeling is affected by differential use of fore limbs. Such data indicate that differences in side to side utilization of limbs and differential loading environments have important implications for the understanding of remodeling of cortical bone. To further increase our understanding of the functional implications of histomorphology of bone, we are now investigating the microstructure of auditory ossicles in humans. Preliminary results (AJPA Suppl. 28: 140 (1999)) suggest there are no side-to-side differences in gross morphology of the ossicles, nor any sex-related differences. We are now investigating potential variation in their microstructure.

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Mangabey systematics: implications of reproductive characteristics. S.E. WALKER, Dept. of Sociology and Anthropology, Southwest Missouri State University, Springfield, MO 65904, L.P. FIELD, Sacramento Zoo, Sacramento, CA 95822, and E. STRASSER, Dept. of Anthropology, California State University, Sacramento, Sacramento, CA 95819.

This paper investigates the phylogenetic relationships of mangabeys using data collected on reproductive parameters of captive golden-bellied mangabeys (*Cercocebus galerritus chrysogaster*) as well as on a range of phylogenetic and ecological variables taken from the literature on various mangabey species. Several mangabey species have been studied in the wild and in captivity; we here provide a synthesis of this valuable information. While there has been general agreement among workers on the separation of mangabeys into two monophyletic groups, one semi-terrestrial (*Cercocebus*) and one arboreal (*Lophocebus*), questions still arise as to the common origin of the group, the affinities of mangabeys to other papionins, and the number of species and subspecies involved. Addressing these questions is difficult due to the lack of concordance among studies in terms of nomenclature as well as the various ways of interpreting and presenting data on behavior and reproduction.

Observations on the reproductive state of five female golden-bellied mangabeys at the Sacramento Zoo have been conducted daily from 1986 to the present. These data on such variables as cycle length, menses length, interbirth interval and gestation length are compared to those of other mangabeys for which data exist. The results demonstrate that characteristics such as heavy and visible menses and postconception perineal swelling support the place of *C. g. chrysogaster* within the semi-terrestrial group, with its typical multi-male mating system. These results are in accordance with those of other studies on reproduction, behavior, genetics and anatomy.

Sex determination of Portuguese femur and humerus by discriminant functions. S.N.WASTERLAIN, H.CARDOSO and E.CUNHA, Departamento de Antropologia, Faculdade de Ciências e Tecnologia, Universidade de Coimbra, 3000-056 Coimbra, Portugal.

Sex determination from long bones plays an important role in the field of anthropology and forensic medicine. Several studies have demonstrated that populations differ from each other in size and proportions and that these differences can affect the metric assessment of sex. The purpose of this research is to provide a method

of sex determination for femur and humerus. The analyzed sample is made up of 400 identified skeletons (200 males, 200 females), chosen from the Identified Skeletal Collection of the Museu Antropológico from Coimbra University (N=200) and from the Identified Skeletal Collection (Luis Lopes Collection) housed in the Museu Bocage from Lisbon University (N=200). Fourteen standard osteometric dimensions were taken, seven on each bone, which were subsequently treated by stepwise discriminant analysis. Results indicate that humerus, yielding around 93% accuracy, is more reliable for sex diagnosis than the femur, which yields approximately 87% accuracy.

Predicting catarrhine hand bone lengths and their inferential value to the understanding of the evolution of locomotion. B.T. WATKINS, Department of Earth Sciences, University of Liverpool, Liverpool, England and J.C. OHMAN, School of Biological & Earth Sciences, Liverpool John Moores University, Liverpool, England.

Fossil catarrhine hand bones have been recovered for some time, and in recent years, a comparatively large cache of isolated and bone fossils have been recovered from primate-bearing sediments in Southern Europe, East and South Africa and Asia. Intense study, mostly on extant analogs, has followed, but no published attempts have ever been made to reconstruct the hand by predicting the lengths of the missing hand bones from isolated fossil hand bones. Results indicate that the 27 regression combinations run on the hand bones of 26 extant species of Old World primates produced correlation coefficients ranging from 0.908 to 0.999. Metacarpal lengths produced highly accurate predictions, but also divided the sample populations into two broad locomotor categories: arboreal and terrestrial. On the basis of these results, predicting hand bone lengths have five significant functional and evolutionary implications: 1) in general, the predictions are well within the 95% envelope, with acceptable mean prediction errors, and, therefore, can be applied to a wider range of extinct catarrhines; 2) the utilization of metacarpals II-V as predictors in the 'all catarrhine' group, provides a broad indication of locomotor behavior; 3) a corollary of #2 is that these appear independent of phylogenetic relationships; 4) adjustments to the lengths of individual bones, within and between rays II-V, still allow functional integrity of the hand for the maintenance of its particular locomotor habit; and 5) the regression equations can be employed to make inferences about the locomotor habitus

Degenerative indicators of work stress in enslaved Africans in Colonial New York. R.L. WATKINS, University of North Carolina, Chapel Hill, NC 27599, A.J. HANKIN, and M.E. MACK, Howard University, Washington, DC 20059.

This paper presents data on osteoarthritic and degenerative changes among males and females in the New York African Burial Ground. Of 53 females sampled 47.1% (n=25) exhibited arthritic changes in the diarthroidal joints and 39.6% (n=21) exhibited vertebral osteophytes. Of 78 males sampled 74.3% (n=58) and 42.3% (n=33) were affected by these respective pathologies. Additionally, degenerative involvement in the hip, knee and wrist was shown to be more prevalent in males, although similar mean frequencies of arthritic indicators were observed in both sexes.

The high prevalence of cervical vertebral osteophytes and the presence of burst fractures effecting the first cervical vertebra and cranial base suggest lifting and carrying heavy loads on the head as a work behavior. However, osteophytic lesions affecting females suggest more use of the neck while those lesions exhibited in males indicate more extensive use of the mid and lower back muscles.

These results suggest that differences in the pattern and frequency of degenerative indicators between males and females are likely due to older ages-at-death for males, and variation in work activities. These findings underscore the need for further research towards understanding differences in the culture of work between males and females in enslaved populations which influence patterns of degenerative change.

A quantitative study of artificial cranial deformation: bio-cultural behavior in Southwest prehistory. J.T. WATSON, Department of Anthropology, Wichita State University, KS 67260.

This research attempted to quantify the bio-cultural behavior producing artificial cranial deformation in the prehistoric American Southwest. The two types of deformation considered in this study were antero-posterior and lambdoid. Both are characteristic of the Puebloan cultural practice of cradle-boarding infants. The cultural difference that results in lambdoid deformation and a difference in morphology, is the use of a pillow in the placement of the child on the cradle-board. Deformed crania were measured from collections at the University of New Mexico. These data were applied to statistical models of analysis to extrapolate potential metric differences in class variables.

Quantifiable differences were found between male and female crania, and between antero-posterior and lambdoid deformed crania, but the main effects of these respective differences had no interaction between the class variables. Models of metric

variables most significant for discerning deformation type were developed. The results of these analyses revealed that, by using certain metric variables, it is possible to quantify the subjective morphological categories of antero-posterior and lambdoid deformation.

It was concluded that quantitative classification of deformation type was possible using the metric variables that represented the region of the cranium affected by the deformation process. The cultural practices associated with this deformation difference are thus also quantifiable. A model for future research and for expansion of the quantification of bio-cultural behavior was developed.

Chimpanzee predation on red colobus monkeys at Ngogo, Kibale National Park, Uganda. D.P. WATTS, Anthropology, Yale University, New Haven, CT, 06511, and J.C. MITANI, Anthropology, University of Michigan, Ann Arbor, MI., 48109.

Chimpanzees in the Kibale National Park, Uganda, prey on at least seven mammal species. Red colobus monkeys are their main prey, as at other sites where the two species are sympatric. We present new data on chimpanzee predation on red colobus at Ngogo, in Kibale, and use these to supplement earlier data, to examine temporal variation in hunting frequency, and to examine the hypothesis that male chimpanzees trade meat for matings.

The Ngogo chimpanzee community is the largest (>130 members), and has the most adult males (24), of any known chimpanzee community. Hunting is not unusually common there, but the large number of males leads to an extremely high success rate (>80%) and a high mean number of kills per hunt. Offtake increases with hunting party size, with a maximum of 13 kills in one hunt. Most hunts occur during "patrols" for monkeys. Temporal variation in hunting frequency is positively associated with variation in fruit abundance; notably, large crops of *Uvariopsis congensis* fruit trigger occasional hunting binges. Males share meat reciprocally with each other and sometimes share with estrous females. However, the data do not strongly support arguments that the presence of estrous females influences hunting decisions or that meat sharing with estrous females increases male mating success. Supported by grants from NSF and the L.S.B. Leakey Foundation

MRI, image processing, and evaluation of endocranial structures. A.H. WEAVER, Dept. of Anthropology, University of New Mexico, Albuquerque NM 87131

Most functional regions of the brain register ambiguously on fossil hominid endocasts. The cerebellum, occupying the posterior cranial fossa (PCF), is an exception. Functionally and ontologically discrete, the cerebellum has undergone volumetric and organizational changes since African apes and hominids diverged; and it may play a cognitive role in manipulation and language.

The cerebellum is not the only occupant of the PCF. Moreover, it protrudes supero-rostrally beyond the PCF through a hiatus in the tentorium cerebelli. In order to evaluate cerebellar proportions in fossil hominids we must (1) develop methods to relate cerebellar and PCF volumes; (2) determine whether this relationship is consistent from taxon to taxon.

MRI scans permit us to relate hard and soft tissues (endocranium and cerebellum) but a number of technical problems must be addressed to produce reliable results. This paper describes methods for standardizing results and enhancing replicability despite variations in quality and inconsistencies in orientation among scans; for delineating structures with similar density thresholds; and for identifying the superior PCF boundaries.

This methodology establishes that among hominoids cerebellar volume across taxa is highly correlated with PCF volume (r^2 across taxa, 0.92). Within taxon variability is greater (from $r^2 = 0.49$ for *Pan* to 0.99 for modern *Homo*). Applied to fossil hominids, regression equations developed from MRIs relating cerebellum and PCF volumes will enhance our understanding of human cognitive evolution.

Thanks to John Csernansky, Thomas Insel, and James Rilling for access to MRIs; to Katerina Semendeferi, designer of the primate MRI project; and to Lei Wang for technical assistance. Aided by grants from Student Research Allocations Committee, GPSA, & the Office of Graduate Studies, Univ. of New Mexico.

Thickness mapping of the occipital bone based on CT-data. G.W. WEBER¹, J. KIM², H. SEIDLER¹. ¹ Institute of Anthropology, University of Vienna, Althanstrasse 14, 1090 Vienna, Austria, ² Institute of Mathematics, University of Vienna, Strudlhofstiege 4, 1090 Vienna, Austria.

Information about the thickness of cranial bones is not only of great interest for problems relating to medical techniques, particularly preoperative surgical planning, but just as informative for investigations of fossil hominid material in the field of paleoanthropology. Though very useful, not much data is available for use in both these disciplines. Intra- and inter-specific variation is poorly

known and mostly dependent on measurements taken on a handful of landmarks or not well defined points. These studies fall short of offering sufficient information about the structural details of skulls, especially when taking into consideration the specific endo- and exo-cranial qualities. Other authors have undertaken efforts to develop thickness maps of the cranial vault, but again with the restriction of very limited number of measuring points.

We demonstrate a new approach, using CT-data of occipital bones of recent *H. sapiens* and of fossilized hominids. The data has a higher degree of resolution (0.4 mm edge-length voxels). From every point on the surface of the scanned bone we can measure the cranial thickness with the help of a newly developed algorithm and the results can be presented in matrix form (for further statistical analysis) or as a thickness map of the investigated bone. The presented method is a part of our "Virtual Anthropology" project dealing with the 3D-analysis of CT-data of recent and fossil hominids.

Grip repertoire in captive western lowland gorillas (*Gorilla gorilla gorilla*) and its morphological correlates. S. WEINBERGER, Anthropology, Boston University, MA 02215.

Hand use in chimpanzees is well-documented in the anthropological literature. However, gorillas have been subject to relatively few studies of hand use. This study was undertaken in a preliminary effort to characterize captive gorilla hand use and its morphological correlates, as well as to compare gorilla hand use and skeletal anatomy to that of chimpanzees and humans.

Captive gorillas housed at the Franklin Park Zoo in Boston MA, were videotaped and the frequency of grips was quantified. Grips were classified as either a precision grip or a power grip. The results were then compared to grips observed in captive chimpanzees as documented in the literature. Skeletal features thought to be associated with locomotion and object manipulation were measured in gorillas, chimpanzees and humans. These features included relative ray length, relative robusticity of metacarpals and digits and relative robusticity of metacarpal heads.

The grip most frequently used by gorillas was the pad to side precision grip. Behavioral data also suggest that gorilla grip repertoire is distinguished from that of chimpanzees by the presence of 3 grips observed in gorillas not found in chimpanzees. These are the 3-jaw chuck, the pad to side hook grip and the scissor grip. Measurements of skeletal anatomy indicate a suite of adaptations in gorilla hands facilitating a precision grip. These include a long pollical metacarpal relative to a shorter second and third metacarpal, a longer pollical proximal phalanx relative to the third proximal phalanx and a robust pollical metacarpal.

Contrary to previous studies (Susman, 1994 and 1995), suggesting that ape grips are not characterized by precision, preliminary findings in this study suggest that gorilla grip repertoire includes a strong emphasis on precision. In addition, in some cases, skeletal features associated with object manipulation in gorillas more closely resemble those of humans than those of chimpanzees.

The effects of body size and climate on *Macaca* fore- and hindlimb lengths. K. J. WEINSTEIN, Department of Anthropology, University of Florida, Gainesville, 32611.

Cercopithecine limbs scale with body size in a pattern characteristic of arboreal and terrestrial quadrupedalism. Cercopithecine forelimbs are positively allometric with body size due to positive allometry of both the humerus and radius, while the hindlimb is negatively allometric with body size due to the isometry of the femur and negative allometry of the tibia. *Macaca* species, however, exhibit extreme negative allometry in the hindlimb when compared with other cercopithecine genera. Because some *Macaca* inhabit temperate latitudes and high altitudes, limb lengths in this genus may be following the predictions of Allen's Rule in which species that inhabit cold climates exhibit short appendages when compared with their tropical conspecifics and congeners.

This study compares the scaling relationship of limb lengths with body size in six *Macaca* species (N=203) in order to: 1) identify which species diverge from the general cercopithecine allometric pattern, and 2) test whether the species that exhibit extreme negatively allometric limbs are those species that inhabit colder climates. I collected maximum lengths of the femur, tibia, humerus, and radius of wild-shot adult skeletons of *M. assamensis* (n=10), *M. fascicularis* (n=70), *M. fuscata* (n=43), *M. mulatta* (n=38), *M. nemestrina* (n=31), and *M. thibetana* (n=11). Body weight was recorded from each skeleton when available or taken from the literature. Least squares and reduced major axis linear regressions of log-transformed long bone lengths and body weight were used to identify how the fore- and hindlimbs scale with body weight for sex-specific species groups. Latitude, altitude, and lowest mean monthly temperature recorded from weather stations located nearest to each specimen's recovery site were correlated with limb lengths to test whether climate contributes to *Macaca* limb length variation.

Negative allometry of the femur and tibia, and slightly negative allometry of the humerus and radius characterize both male and female limbs. Long bone lengths in *M. fascicularis* and *M. nemestrina* scale close to isometry, while those of the northern and highland species consistently exhibit negative allometry with body weight. Correlations of climatic variables with limb lengths indicate that the relatively short appendages of *M. mulatta*, *M. fuscata*, and *M. thibetana* may be an adaptation to cold climates in which short limbs conserve body heat. These results suggest that while *Macaca* limb lengths follow a scaling pattern similar to other cercopithecines, climatic factors may also influence variation in *Macaca* body proportions.

Effects of formalin fixation and desiccation on bone strain patterns in primate long bones. D.A. WEISS, Department of Anthropology, UC Davis, Davis, CA 95616 and D.J. DAEGLING, Department of Basic Medical Sciences, California College of Podiatric Medicine, San Francisco, CA 94115.

Experimental observations of bone strain under controlled loads provide an empirical baseline from

which biomechanical models of skeletal behavior can be refined. Collection of strain data across large samples could provide critical information about the mechanical consequences of morphological variation not discernible through conventional application of beam theory.

Dry and chemically preserved osteological specimens are potentially rich sources of comparative material to test biomechanical hypotheses. It is suspected, however, that the processes of drying and preservation significantly alter the material properties of bone. Indeed, the published literature is in conflict with respect to the mechanical effects of formalin fixation.

We harvested long bones from a frozen, unperfused *Cercopithecus aethiops* adult male cadaver, bonded strain gages to periosteal surfaces, and loaded each specimen in three-point bending on an MTS Mini-bionix testing system (Minneapolis, MN). Specimens were then placed in 10% formalin for seven weeks and retested under identical loading conditions. Each specimen was again tested after 24 and 48 hours of drying at 21° C.

Errors associated with signal sampling, load cell performance, gage output over time, and specimen restraint were estimated. Of these factors, gage degradation due to immersion in formalin emerged as a significant source of error, with restraint of specimens also contributing to interpretive problems. Accounting for these sources of error, we found that 1) formalin fixation resulted in significantly higher strains for a given load, and 2) drying of specimens resulted in modest alterations of strain gradients, with attendant changes in principal strain directions. These results suggest that qualitative predictions may be productively informed by experimental data from preserved material, but that formulating determinate quantitative models from such data may be inadvisable.

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Temporal Differences in Quality of Life in Two Central Californian Native American Populations. E. WEISS, ENDY, University of Arkansas at Fayetteville, AR 72701.

This project examines the skeletal remains of two cemeteries from the San Joaquin Valley to determine quality of life changes through time. Cemetery 1 dates from 3000 to 1900 year before present (BP); Cemetery 2 dates from 1300 to 1200 BP. Changes in the quality of life of these peoples are assessed by examining pathology/trauma frequency, age of death, and cortical thickness.

Pathologies and traumas in young people are often related to disease, intense labor, or warfare. Average age at time of death is often used as an indicator of quality of life. An old average age at time of death signifies adequate nutrition, care for the elderly, low infant and child mortality, and low mortality during birth. Cortical bone is also a good indicator of life quality. Cortical bone becomes resorbed throughout life; however, resorption is increased when nutrition is low. Conversely, cortical bone is only deposited with proper nutrition consumption and stresses.

Data on pathologies/traumas and age of deaths come from the CA-SJO-91 Collection Catalog Verification Report from the California State University, Sacramento. Computer tomography is used to obtain femoral midshaft

cross-sections of sixty individuals. Six measurements from the medullary cavity to the end of the cortical bone are taken for each cross-section and averaged to obtain a cortical thickness value following Dewey et al. (1969). Analyses of Variance are used to determine whether differences in means and variances of the ratios for the two cemeteries are significant. Sex and age are controlled for in both pathology/trauma frequency and cortical thickness measurements.

Analyses reveal that the quality of life decreased from Cemetery 1 to Cemetery 2. Female quality of life decreased more drastically than did male quality of life. Both sexes, however, show an increase in pathology and trauma frequency, decrease in age at time of death, and a decrease in cortical thickness. Studies on Californian climate suggest that a severe drought period started around 1300 BP (Jones et al. 1999). Droughts have been known to cause declines in quality of life through increased warfare for resources and lower nutritional intakes. The decrease in the quality of life noted in Cemetery 2 is suggested to have resulted from the drought.

The status of federal support for a Human Origins Initiative. M.L. WEISS, Physical Anthropology and J. YELLEN, Archaeology, National Science Foundation, Arlington, VA 22230.

The National Science Foundation is the largest funding source for research into human evolution in the United States. The vast majority of proposals are motivated by PI interests and involve small numbers of individuals working on relatively narrow topics. Since the Foundation established a program in Physical Anthropology in 1989, it has provided approximately \$25 million in support of these activities; additional funding comes through Archaeology. However, the demand for resources far exceeds availability and the requests increase at a faster rate than the programs' allotments. During one recent competition, for instance, PIs requested \$8.9m but commitments could be made for approximately \$800k.

The philosophy at NSF is changing. The priority has shifted towards interdisciplinary, large-scale projects that make use of distributed databases, the power of the web and other 'high tech' approaches to science. In an attempt to increase the funding opportunities for research into human evolution we are pursuing a request for a Human Origins Initiative. Human Origins is defined broadly, including both micro- and macro-level changes in genetic, morphological and behavioral systems and their interfaces. This insures access by a broad diversity of scientists and broad support within the Foundation. If funded the Initiative will provide funds for highly collaborative research across disciplines. It would favor approaches that unite, possibly via electronic or other innovative approaches, themes and disciplines that historically have experienced little cross-talk. Molecular techniques capable of resolving questions of interest to physical anthropology and archaeology would seem particularly appropriate.

Variability in howler monkey choice of sleeping and resting sites. B.J. WELKER and G.V. HUNT, Anthropology, SUNY at Geneseo, NY 14454.

It was hypothesized that howler monkeys may use different decision rules when choosing daytime versus nighttime resting/sleeping sites because of differing environmental pressures. Shade was proposed as the most important variable affecting daytime choice of resting sites while predator avoidance was thought to be the primary nocturnal concern.

Data for this study were collected while observing one group of free-ranging howler monkeys in Sector Santa Rosa, Area de Conservacion Guanacaste, Costa Rica. The study took place in dry tropical forest during the dry season in early 1999. At this time of year, days are typically sunny and hot and most trees in the study area lose many or all of their leaves.

Data were collected using resting animals during their long afternoon rest period and again when they retired for the night. The following variables were measured: (1) tree species, architecture, size, and percent foliage (2) monkey height, distance from the trunk, distance to nearest neighbor, and whether the individual was positioned under foliage, and (3) substrate characteristics.

There were significant differences between diurnal and nocturnal sites that support our propositions. The diurnal pattern was as follows: (1) trees had more foliage and a more closed canopy and (2) monkeys were more often clustered together and positioned closer to the trunk, under foliage, and on larger substrates. Conversely, the nocturnal pattern was as follows: (1) trees were taller and had less foliage and a more open canopy and (2) monkeys positioned themselves higher, farther away from the trunk and each other, and on smaller terminal branches.

These results were interpreted as convincing evidence that monkeys position themselves well under the densest portion of the tree canopy by day to avoid the sun and heat. At night, they spread out onto smaller terminal branches in open canopy trees. We believe that a reasonable assertion is that smaller branches will more readily notify a sleeping monkey of any approaching animal. Likewise, by moving a moderate distance away from other group members, a sleeping individual will not be confused by movements of other group members.

Genetic systems of color vision in primates.
WEN-HSIUNG LI, Department of Ecology and Evolution, University of Chicago, 1101 East 57th Street, Chicago, IL 60637

It is commonly believed that trichromatic vision is restricted to humans, apes, and Old World monkeys, while all other primates are totally color blind, monochromatic, or at best dichromatic. However, we and others have found that a tri-allelic system at the X-linked opsin locus enables heterozygous females to be trichromatic in the majority of New World monkeys. This system appears to be ancient and has probably been maintained by heterozygote advantage. We have estimated that it is older than 20 million years.

Our new findings about color vision in prosimians are even more surprising. As the vast majority of living prosimians are nocturnal, they are believed to have no color vision and are thought to have been derived from a nocturnal common ancestor. However, our molecular genetic study provides strong evidence that trichromatic vision existed in ancestral prosimians and has persisted in diurnal prosimians. We also have data indicating that the common ancestors of prosimians were diurnal or at least had not undergone a long period of strong nocturnality.

In short, our data suggest that (1) trichromatic vision started in prosimians rather in simians, (2) the last common ancestor of prosimians was diurnal and (3) nocturnality evolved gradually in different prosimian lineages.

Human origins, ancient and modern: implications of computer models. K.P. WESSEN & C.E. OXNARD, Department of Anatomy and Human Biology, University of Western Australia, WA 6907, Australia.

Determining the time and place of human origins employs data from both the very substantial fossil record, and the genetic variation of mitochondrial DNA and Y chromosomes in living peoples. There is as yet no total consensus on either the timeframe involved, or the history of migrations that have lead to the pattern of modern human diversity.

We have here developed computer models to allow multiple simulations of three aspects of this problem. The simplest model, in which each species is defined by a suite of discrete "characters", a small number of which may vary as each species evolves, was presented last year. Phylogenies are reconstructed from the simulated data in two ways, one by matching characters of existing species and fossils, and another using a Wagner distance algorithm based on characters of existing species alone. The reconstructions can then be compared with the true phylogenies.

A second model greatly extends the first by allowing simulation of migrations and interbreeding of groups or subspecies. The characters are now more complex through additional modelling of non-hereditary as well as hereditary influences, and defining them, when appropriate, as primitive or shared derived.

A third, still preliminary, model involves producing lineages of individuals, with ability to reconstruct the genetic relationships and migratory histories related to mtDNA, Y chromosome and nuclear DNA data. These simulations allow examination of different mating patterns, sex ratios and degrees of consanguinity etc.

Thousands of reconstructed phylogenies imply more recent common ancestors, more fossils on lineages leading to extant forms, and fewer migrations than exist in the true phylogenies. These differences are not due to the models being overly simple because they account for far more factors than are normally included in studies of fossils or molecules. It is hoped that a better understanding of these matters at all three levels (species, subspecies and individuals), will help to overcome problems of limited data in estimating time and place of common ancestors.

Artificial Cranial Deformation on the Northwest Coast:
The Pender Canal Site, British Columbia, Canada.
D.A. WESTON, Institute of Archaeology, University
College London, London, UK WC1H 0PY

Sixty-three prehistoric crania from the Pender Canal Site (ca. 5000-1000 B.P.) in British Columbia, Canada, were analysed to determine the presence or absence of artificial cranial deformation. Two types of artificial cranial deformation, lambdoidal and fronto-occipital, were identified and there was a clear temporal sequence of deformation styles.

The earliest artificially deformed skull in the sample, also believed to be the earliest deformed skull found in British Columbia (5170 ± 220 B.P.), is lambdoidally deformed. It is likely that this deformation occurred unintentionally, possibly due to the use of a cradle-board. The first intentionally deformed skulls (fronto-occipital) occur later at between 2000-3000 years B.P.

Ethnographic evidence indicates that intentional artificial cranial deformation was practised in this population as a means of displaying social status. The presence of cranial deformation in antiquity, along with other lines of archaeological evidence, attests to the longevity of the ethnographically observed Northwest Coast culture pattern.

The identification of foreigners in mortuary contexts using oxygen-isotope ratios: Some Mesoamerican examples. C.D. WHITE and M.W. SPENCE, Department of Anthropology, F.J. LONGSTAFFE, Department of Earth Sciences, The University of Western Ontario, ON Canada N6A 5C2.

The reconstruction of relationships within and between human skeletal populations is currently experiencing a rebirth due to the development of technology to analyse ancient DNA. To illustrate an alternate means of identifying foreigners in mortuary contexts, we present oxygen-isotope data from phosphate of human bone and enamel from several Mesoamerican sites (Altun Ha, Rio Azul, Kaminaljuyu, Teotihuacan). The isotopic approach is based on the premise that we are a chemical reflection of the water sources in our environment. It is distinguished from the genetic technique because it has a potential to identify the relocation of individuals within the same genetic group and to detect geographic movement during periods of tooth enamel formation.

A baseline of isotopic values for Teotihuacan, Mexico was previously established using the local apartment compound of Tlajinga 33 (mean $\delta^{18}\text{O}_p = 14.7\text{‰}$) (White et al., 1998). Altun Ha, Rio Azul and Kaminaljuyu are Maya sites from different environments producing contrasting $\delta^{18}\text{O}_p$ values and have yielded individuals suspected to have been from the powerful state of Teotihuacan.

The hypothesis that Teotihuacan had conquered Kaminaljuyu, Guatemala was unsupported with our data (White et al., 1999). Similarly, individuals who were found at Altun Ha and Rio Azul, and who also appeared to have Teotihuacan connections on the basis of mortuary data, did not have isotopic signatures consistent with those from Teotihuacan. Thus the chemical data suggest that Teotihuacan's influence on the Maya world was dominantly symbolic rather than physical.

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Neocortical and neocerebellar expansion in *Paranthropus* endocasts and their bearing on basicranial similarities with *Homo*. D.D. WHITE, Dept. of Anthropology, University at Albany, SUNY, Albany NY 12222

Since the first detailed description of the *Paranthropus boisei* specimen OH 5 (Tobias, 1967), some workers have observed that the cerebellar hemispheres of robust australopithecines appear to be reminiscent of more advanced hominids (*Homo*-like) when compared to the primitive condition in gracile australopithecines and *Pan* (ape-like). The lateral cerebellar hemispheres of *Paranthropus* seem to be wide, protruding and tucked well under the occipital lobe as in modern *Homo*. This hypothesized neocortical and particularly neocerebellar expansion in *Paranthropus* has been invoked to explain the similarities in cranial base morphology (basicranial flexion and petrous bone angle) between this group and modern *Homo sapiens* (Dean, 1988) yet very little metric data exist to support these observations.

In an attempt to test the neocortical / neocerebellar expansion hypothesis we quantified and statistically compared the endocranial occipital and cerebellar morphology of *Paranthropus* (OH 5, KNM-ER 23000, SK 1585, KNM-ER 407, KNM-ER 17000), *Australopithecus* (Sts 5, KNM-ER 1805, KNM-ER 1813), *Homo* (KNM-ER 1470, KNM-ER 3883, 5 modern *Homo sapiens*) and great apes (*Pan troglodytes*, *Pan paniscus*, *Gorilla gorilla*, *Pongo pygmaeus*). Ten measurements were taken and compared using univariate statistical techniques.

Our preliminary findings do not support the hypothesis that *Paranthropus* cerebellar hemispheres are more advanced or *Homo*-like than *Australopithecus* or *Pan* cerebellar hemispheres. In fact *Paranthropus* cerebellar morphology closely resembles *Gorilla* cerebellar morphology. These data also suggest that *Paranthropus* and *Australopithecus* cerebellar regions are metrically indistinguishable from one another. However, the parieto-occipital region of *Paranthropus* and *Australopithecus* were significantly larger than those of the great apes suggesting a greater neocortical rather than neocerebellar compression within the evolving hominid cranium.

An endocrine biomarker of life history in male primates. P. L. WHITTEN, Emory University, Atlanta, GA 30322 and T. R. TURNER, University of Wisconsin-Milwaukee, Milwaukee, WI 53201.

Hormones are likely to play key roles in the evolution of life history. To be an effective regulator of life history, a hormone should act throughout the lifespan, influence multiple traits, respond to environmental variation, and induce life-history trade-offs. The adrenal androgen dehydroepiandrosterone and its sulfate, DHEAS, are attractive candidates for such a role. Both decline with age in humans, and individual differences in age-specific serum concentrations are associated with differences in life expectancy and age-related dysfunction. Moreover, their more rapid decline in rhesus macaques and baboons suggests that these hormones may be biomarkers of aging in primates.

This study examined the suitability of DHEAS as a biomarker of aging and a potential regulator of life history in primates. The objectives were to determine whether DHEAS varied predictably with age, life expectancy, and reproductive effort in feral vervet monkeys. Serum samples were obtained from adult males in four ecologically distinct populations in Kenya. Ages were estimated based on patterns of dental eruption and wear and ranged from 4-20 years. Concentrations of DHEAS in serum samples from 57 adult males were determined by radioimmunoassay.

Serum DHEAS concentrations were substantially lower than concentrations reported for humans or captive rhesus macaques but were similar to concentrations reported for feral baboons. An age-related decline in male DHEAS was evident across all populations. Comparisons of age-specific DHEAS concentrations to population age structure suggested that the pattern of decline reflected life expectancy. Data on group composition, body size, and serum testosterone levels provided evidence for a link between DHEAS and reproductive effort. These patterns support the use of DHEAS as a biomarker of aging and life history in primates and argue for further investigation into its role as a potential regulator of life history.

Probability of genotyping of the polymorphic apolipoprotein E (APOE) in ancient human DNA samples. I. WIECHMANN and G. GRUPE, Institute of Anthropology and Human Genetics, Ludwig-Maximilians-University, 80333 Munich, Germany.

The study of ancient DNA is a promising approach to a range of issues, including disease in the past. In this connection the present paper focuses on the purpose to retrieve DNA sequences of the polymorphic apolipoprotein E (APOE) from ancient human DNA extracts. Apolipoprotein E circulates in plasma as a component of chylomicron remnants, VLDL and HDL. In human populations three common APOE alleles, APOE*2, APOE*3 and APOE*4, exist at the APOE locus on chromosome

19q13.2. The most frequent isoform APOE 3 has cysteine at position 112 and arginine at position 158. APOE 2 and APOE 4 differ by single amino acid substitutions at one of these two positions of the residue protein. APOE 2 has cysteine at position 158 and APOE 4 has arginine at position 112. The different APOE isoforms have significant effects on the normal variation of plasma lipid levels.

The conventional method for the molecular genetic determination of the major APOE alleles is based on a 244 bp amplification product covering the codons for amino acids 112 and 158 (Emi et al. 1988, Hixson & Vernier 1990), which was digested with Hha I. Since ancient DNA target regions for amplification are generally quite small, a modified method for APOE genotyping based on short amplification products in the range from 71 bp to 75 bp was established. For modern human DNA samples the applicability of this detection method for typing of the common APOE alleles could be confirmed.

The application of this method to ancient human DNA samples requires an efficient, silica-based DNA extraction protocol as well as the accompanied analysis of other informative genetic markers, especially microsatellite length polymorphisms, which are able to verify the authenticity of the ancient DNA specimens under study. Considering this, differentially dated bone and tooth specimens originating from individuals from various burial sites could also be investigated regarding the retrievability of the polymorphic exon 4 APOE sequences.

Evolution of mitochondrial DNA in baboons from the Horn of Africa and the Arabian Peninsula. D. E. WILDMAN, P.T. TELFER, C.J. JOLLY, T. R. DISOTELL, Dept. of Anthropology, New York University/NYCEP, New York, NY 10003, T.J. BERGMAN, J.E. PHILLIPS-CONROY, Depts. of Biology, Anthropology, and Anatomy, Washington University, St. Louis, MO 63130, and T.K. NEWMAN, Dept. of Genetics, Southwest Foundation for Biomedical Research, San Antonio, TX 78245.

Baboons (*Papio hamadryas*) from the Horn of Africa and Arabia are evolutionarily interesting because there are divergent forms that interbreed (hamadryas and anubis baboons in Ethiopia) as well as populations of morphologically similar forms that cannot interbreed because of extrinsic barriers to gene flow (hamadryas in Africa and Arabia). To investigate the phylogeographic history of this region we sampled over 70 baboons representing all major forms including >40 hamadryas and anubis from multiple known locations. We sequenced a portion of the ND4/ND5 region of the mitochondrial genome. Parsimony, maximum likelihood, and distance-based methods yield a strongly supported clade representing all Ethiopian and Arabian baboons. Within this Ethiopian and Arabian clade some Arabian hamadryas lineages form a well supported monophyletic clade, but other Arabian lineages group with African hamadryas. Furthermore, Ethiopian anubis baboons group with hamadryas baboons rather than Kenyan anubis.

We tested four hypotheses to account for these observations: selection; nuclear insertion of mtDNA; introgression; and ancestral polymorphism. The first two hypotheses were rejected. While introgression accounts for some of the patterning, ancestral polymorphism may

explain much of the data. Therefore, some mtDNA lineages within the greater Ethiopian/Arabian region may predate population splits between Arabian and African hamadryas and between hamadryas and Ethiopian anubis baboons. These results suggest a more complex history of population subdivision and gene flow than might be expected from current phenotypic and geographic distributions.

Funding provided by the National Science Foundation, Sigma Xi, the American Institute for Yemeni Studies, and the Harry Frank Guggenheim Foundation.

Can shoeprint impression depth aid prediction of body weight? A. WILLIAMS, R. PASTOR and C. KNUSEL, Calvin Wells Laboratory, Department of Archaeological Sciences, University of Bradford, Bradford, BD7 1DP, U.K.

The hypothesis that body weight has an effect on shoeprint impression depth was investigated in two different substrates. A sample of 50 men, wearing identical running shoes, walked through two wooden trays filled with coarse sand and fine, silty soil. The body weight, stature, and shoe size of each subject were recorded. Depth measurements of the shoeprint impressions were taken at 20 specific landmark points chosen to correspond with the four main weight-bearing regions of the foot (toe, ball, arch and heel). Total depth, length and width measurements of the impressions were also taken with a modified caliper.

Results from non-parametric bivariate correlation tests (Spearman's and Kendall's tau-b) corroborate the hypothesis that body weight is significantly correlated ($p < 0.01$) with shoeprint impression depth, at all the designated points. Similar tests showed that both the bodymass index (weight/height) and the shoe size index (bodymass \times 100/shoe size) were significantly correlated ($p < 0.05$) with shoeprint impression depth, although not as highly as with body weight. Spearman's tests showed that in soil the total and toe depth values had the highest significant correlation with body weight (0.536 and 0.528, respectively, $p < 0.01$). In sand, arch depth values showed the highest significant correlation with body weight (0.416, $p < 0.01$).

Regression equations were created to predict body weight from depth values of the different regions of the impression. R^2 values for the total depth and the toe region in the soil were the highest of all the data, although still relatively low (0.371 and 0.344, respectively). Regression equations were calculated to predict shoe size from the dimensions of the shoeprint ($R^2 = 0.699$ in soil) to elaborate on Van Hoven's work (1985). Blind tests were carried out on subjects with unknown weights and shoe sizes to assess the reliability of the prediction formulae in both indoor substrates and a real outdoor substrate. Formulae for the indoor and outdoor soils were found to give more accurate estimates of body weight and shoe size than those for sand. The prediction formulae were devised to explore the possibility of using shoeprint and footprint impression depth as a predictor of body weight in forensic and palaeoanthropological contexts.

Comparing craniofacial growth in modern humans, Neandertals, bonobos and chimpanzees using nonlinear piecewise regression. F.L. WILLIAMS, Anthropology, University of Massachusetts at Amherst, MA 01003.

Craniofacial traits of the calotte, face and mandible, from ontogenetic series of modern humans ($n = 298$), Neandertals ($n = 42$), bonobos ($n = 152$), and chimpanzees ($n = 156$) were plotted against age. Piecewise regression, a second order polynomial, was used to model these growth data. From a maximum of 50 iterations using 20 half-steps of Gauss-Newton least-squares, four coefficients were obtained for each craniofacial trait. The likelihood surface used to interpolate these ontogenetic trajectories was constrained by imposing minimum and maximum values for the four coefficients. Starting values provided initial estimates to locate global versus local minimums for the four coefficients, and thus the best fits of the data to the model.

The four coefficients obtained for each trait were then examined in separate Principal Components Analyses for the calotte, face and mandible. The goal was to identify differences in the growth parameters of the taxa.

For all analyses, PCA 1 separates *Pan* from *Homo*. In the PCA of the calotte, the second axis strongly polarizes Neandertals and modern humans, and the third axis does the same for chimpanzees and bonobos. This suggests that the differences in calotte growth which distinguish modern humans from Neandertals are greater than those separating bonobos from chimpanzees. In both face and mandible second PCA axes, the distances between bonobos and chimpanzees, and between Neandertals and modern humans, are much more comparable, although bonobos and chimpanzees are slightly farther apart. These parallel differences in facial and mandibular growth parameters stem from the relatively greater degree of prognathism in chimpanzees and Neandertals compared to bonobos and modern humans respectively.

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Skeletal analysis from late Roman/ Byzantine tomb: Yasileh, tomb 361. K.D. WILLIAMS, Anthropology, University of Arkansas at Fayetteville, AR 72701.

Tomb 361 was excavated during the 1998 Yarmouk University Institute of Archaeology and Anthropology and the University of Arkansas joint excavation at the site of Yasileh, located

9km east of Irbid, Jordan in the area of modern Jordan, Syria, and Palestine. Based on artifacts recovered during previous excavation, the site's main period of occupation was determined to be the late Roman/Byzantine period. Tomb 361 is a single chamber with a horizontal shaft entrance carved into the side of the limestone hill located in the north-west cemetery of the site. A large number of intact commingled skeletal elements were recovered and determined to represent at least nine individuals. Males, females, adults, and subadults are all represented. Due to the relative completeness of these remains as compared to the highly fragmented commingled remains from other tombs at Yasileh; it was possible to learn more about the health of the individuals interred. Results include evidence of vertebral pathology, osteoarthritis, and one case of infectious response to an adult innominate. Funding for the excavation was provided by the King Fahd Middle East Studies Program, University of Arkansas.

Degenerative diseases of the spine in a 19th century poorhouse population. P.M. WILLIAMS, Dept. of Anthropology, SUNY at Buffalo, NY 14261.

In 1984, the Monroe County Parks Department uncovered 305 human skeletons at Highland Park in Rochester, New York while constructing a public facility at this site. Historic records suggest that these remains are part of a cemetery once associated with the Monroe County Almshouse and is believed to have been in use from 1826 to 1863. In an effort to continue the assessment of the health and quality of life of the almshouse inmates, this study focuses on degenerative diseases of the spine, including osteoarthritis and osteophytosis.

Ninety-two male and 56 female skeletons were examined to determine the type and severity of pathological conditions associated with the spine. The data collected include: presence and severity of remodeling including osteophyte formation and 'lipping' of vertebrae and articular facets; incidence and location of joint surface pitting and Schmorl's nodes, and evidence of alteration of joint surface contours.

Thirty-one percent of the adult male and 26.7% of the adult female skeletons displayed signs of degenerative disease of the spine. Nearly one-half of the individuals over the age of 40 were observed to show evidence of this pathological condition (males: 46.4%, females: 47.1%). The highest incidence of degenerative disease of the spine was observed in the thoracic region in both males and

females. Osteoarthritis is most evident in the mid-thoracic region, while osteophytosis remains more prominent in the lower thoracic region. The pathology is seen in moderate proportions in the lower lumbar region and is least severe in cervical regions.

This may be evidence that the pathological condition is the result of the regular flexion common to these particular areas of the spine and may suggest that the majority of cases of osteoarthritis and osteophytosis observed in this poorhouse population are of an idiopathic nature. Although, there is a possibility that many cases may be of a secondary nature due to occupational stress.

The mechanics of tree-gouging in *Callithrix jacchus*. S.H. WILLIAMS, C.J. VINYARD, and C.E. WALL
Department of Biological Anthropology and Anatomy,
Duke University Medical Center, Durham, NC.

Tree-gouging in *Callithrix jacchus* is an unusual feeding behavior that has implications for the ecological and morphological adaptations of the species. However, there are no studies on the mechanics of gouging in any primate, making it difficult to understand this behavior and interpret morphological differences between *Callithrix* and other non-gouging callitrichids. In this study, we quantified the kinetics of the upper and lower jaws during gouging in *C. jacchus* to provide a mechanical basis for interpreting this behavior.

A controlled experimental setup was used to record data on the forces applied by a marmoset to a wooden block that was attached to a force platform. The design permitted application of force to the block only by a subject's head ($n=2$ male *C. jacchus*). The subjects readily gouged the block to extract imbedded food items. Gouging was filmed simultaneously at a minimum of 60 fields/sec. The kinematic and force data were analyzed with Peak Performance Software v. 4.3. The resultant force magnitude and direction and linear gapes were quantified. The timing of these events also was compared.

Analysis of approximately 100 gouges over 9 observational periods shows that gouging tends to occur in bouts of 4 to 10 sequential gouges. Forces transmitted via the masticatory apparatus during gouging range from 2-8N. The maximum peak resultant forces recorded are approximately 2-3 times body mass. Peak horizontal force usually precedes peak vertical force, a pattern that appears related to the use of the upper jaw to anchor the head prior to and during gouging with the lower incisors. This finding supports previous behavioral observations. Linear gapes during gouging range from 6-20mm. Large forces (i.e., > 5N) are applied during gouging at both large and small gapes. The largest gapes approach the maximum passive gape estimates in these subjects. Maximum gape during a gouge occurs prior to peak force; however, near-maximum gapes are maintained during peak force.

During gouging, the high peak forces in both the horizontal and vertical direction coupled with large gapes may have implications for understanding the morphology of the skull of *Callithrix jacchus*.

Ambush at Ft. Laurens: Interpersonal conflict between Colonial Period Native Americans and Europeans in Ohio. M.A. WILLIAMSON, Dept. of Health and Kinesiology, Georgia Southern University, Statesboro, GA 30460, C.A. JOHNSTON, Ohio Historical Society, Columbus, OH, 43211, S.A. SYMES, Dept. of Pathology, University of Tennessee-Memphis, Memphis, TN 38104, J.J. SCHULTZ, Dept. of Anthropology, University of Florida, Gainesville, FL 32611

On October 23, 1778 an expedition of 1200 men led by General Lachlan McIntosh set off from the headquarters of the American Army's Western Department at Ft. Pitt near present day Pittsburgh, Pennsylvania. Their purpose was to attack Detroit, the headquarters of the British in the west. Due to inadequate provisions and a departure date that fell late in the year, the expedition did not make it to Detroit and had to settle on the banks of the Tuscarawas River near the present day town of Bolivar, Ohio. In late November, 1778 General McIntosh ordered the building of a fort at this site and named it Ft. Laurens after Henry Laurens who was, at the time, serving as president of the Continental Congress.

After spending three weeks to build the fort, most of the troops headed back to Ft. McIntosh about halfway between Ft. Laurens and Ft. Pitt. One hundred and seventy-six individuals remained at Ft. Laurens during the winter of 1778-79 and following months. At least 21 individuals were buried in the fort's cemetery during its occupation, 17 of which were supposedly killed and scalped by British soldiers and Native Americans while attempting to gather foraging horses.

The Fort Laurens cemetery sample consists of skeletal remains of twenty individuals. A previously published study by Sciulli and Gramly (1989) documented the biological data and provided a summary of the traumatic lesions. The purpose of this study is to build on this previous work by adding a more detailed analysis of the traumatic lesions in order to better understand what happened to the victims. Lesions were analyzed based on type, location, and dimensions as well as their overall pattern on the skeleton. Results indicate an average of 3.65 lesions per individual; all crania exhibit lesions, however, only four individuals suffered postcranial trauma.

Gross wear and molar morphology in *Alouatta palliata*: a preliminary study using dental topographic analysis. M.D. WILLIAMSON and P.S. UNGAR Anthropology and Center for Advanced Spatial Technologies, University of Arkansas, Fayetteville, AR 72701, M.F. TEAFORD, Cell Biology and Anatomy, Johns Hopkins University, Baltimore, MD 21205, and K.E. GLANDER, Duke University Primate Center, Durham, NC 27710.

A thorough understanding of diet and tooth shape in primates depends on a knowledge of the effects of wear on dental form. This study documents functionally relevant changes in occlusal morphology over time for *Alouatta*

palliata from Hacienda La Pacifica in Guanacaste Province, Costa Rica.

Six monkeys were anesthetized and dental impressions were taken of their M_2 s following usual procedures in July, 1992. Second sets of impressions were taken for these same individuals seven years later in July, 1999. High resolution casts were prepared and scanned to a resolution of 25.4 μ m using a Surveyor 500 (Laser Design, Inc) laser digitizer. Digital elevation maps were analyzed using GRASS 4.1 (US Army Construction Engineering Laboratory), and surface area, mean slope, and δ -slope were calculated for occlusal surfaces of each tooth. Resulting data were rank-transformed, and time-related changes in these variables were assessed using a MANOVA with a randomized block design. Sources of significance were determined using ANOVAs on individual variables.

MANOVA results indicate significant variation in the model. ANOVAs show differences in surface area and mean slope but not δ -slope for individuals between 1992 and 1999 samplings. As expected, the individual teeth show decreasing slopes and surface areas as they wear.

The lack of change in δ -slope with tooth wear may reflect maintenance of surface angularity and function through time. This suggests a way in which *A. palliata* may maintain shear efficiency as their teeth are abraded. We expect that larger samples will allow us to demonstrate specific changes in morphology with wear that can be considered when assessing both changes in chewing efficiency for individuals through time and the relationships between tooth form and function.

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The Origin of Treponematoses in Prehistoric Texas Populations

D. E. Wilson
A.M. Wilson Associates, Inc.

Clearly treponematoses was present in North America prior to the Columbian exchange, but for just how long prior to this time is unclear. From the published literature, some of the earliest cases of treponematoses have been reported in the Central Texas coast (Jackson et al. 1986), Indian Knoll (Brothwell and Burleigh 1975) and Tick Island (Bullen 1972) sites. The central Texas Coast study reports on skeletal material from the Callo del Oso site, which is mostly attributed to the Late Archaic period.

The goal of this study was to show where and when treponematoses originated in Texas. Though the earliest examples of treponematoses in this study date to the Middle Archaic period on the Upper Coast (ca. 5000 - 3500 B.P.), it seems likely that treponematoses will be found in earlier contexts. Lack of sufficient Early Archaic period samples and larger Middle Archaic samples suggest

that more study of this topic is needed. Given that treponematoses has been found in archaeological samples from other Middle Archaic contexts (ca. 6000 - 3000 B.P.) in widely separated sites from Texas, Florida and Kentucky, it is also probable that treponematoses developed at a considerably earlier date throughout the Americas.

Rates of treponematoses did not consistently increase through time, nor was there significant change in the anatomical distribution of skeletal lesions through time in the populations examined.

Strontium-calcium ratio analysis and dietary adaptations of early hominids from South Africa: a reevaluation of interpretive problems in light of new analyses. J.W. WILSON and R.H. TYKOT, Department of Anthropology, University of South Florida, Tampa, FL 33620; J.F. THACKERAY, Department of Palaeontology, Transvaal Museum, Pretoria, South Africa 0001.

Strontium-calcium ratios in fossil bone have been used to reconstruct paleodietary adaptations, and to test the hypothesis that early members of our genus had different diets than other early hominids. The results of an earlier study (Sillen et al. 1995) suggested that contemporaneous hominids may have had different dietary adaptations, but was not consistent with the prevailing hypothesis of scavenging and/or hunting by early *Homo*.

The currently available data suggest differences between *A. robustus* ($Sr/Ca = 0.26 \pm 0.04$, $n=8$) and *Homo* (0.43 , $n=1$), but the small number of samples tested cannot control for potential variability especially among *Homo*. Furthermore, Sr/Ca ratios may vary among potential food resources and by geographic location. Although the range in Sr/Ca ratios observed in carnivores ($0.17-0.22$, $n=14$) and herbivores ($0.3-1.0$, $n=15$) from this region appear not to overlap, it is also possible that *Homo* could have obtained an herbivorous signature through the selective consumption of underground plant storage organs or other plant parts with high Sr/Ca ratios.

The sample-size limitation of the earlier study is addressed through the analysis of an additional fifteen *Australopithecus* and *Homo* fossils from Swartkrans and Sterkfontein, and the natural variability in Sr/Ca ratios is considered in greater detail. A solubility profile procedure involving 20 dilute acid rinses per fossil specimen is used to monitor diagenesis that takes place after burial, and multiple elemental analyses are performed to ensure reproducibility of our results. Our results are evaluated for potential differences in dietary adaptations of these hominid species, and their dietary adaptations relative to other mammals. Finally, the implications of this study for understanding early hominid evolution are discussed.

Support for this research was provided by Sigma Xi and the Transvaal Museum.

Human Remains On Display – Curatorial and Cultural Concerns.

K. WILTSCHKE-SCHROTTA, Department of Archeological Biology and Anthropology, Museum of Natural History, Vienna, 1014 Austria.

D. H. UBELAKER, Department of Anthropology, National Museum of Natural History, Smithsonian Institution, Washington, D.C. 20560.

How can human remains be displayed in a manner which both respects and reflects their humanity? Whenever we as curators put human remains on display in a museum, we are faced with this question, and with a range of overlapping and often conflicting concerns. While we display human remains for their scientific and educational value, and as a way of satisfying the natural curiosity of the visiting public, which wishes to know more about its own species, we surely know that human curiosity takes many forms, ranging from the coolly scientific to the frankly morbid. We know too that different cultures, and religious groups within one culture, hold different belief systems related to the human body, both in life and in death, and have different ideas of what it means to treat human remains with proper respect. This situation as a whole creates a significant problem for curators and organizers of exhibits all over the world in which human remains are on display, and it often also creates a problem for the viewing public. An ongoing fellowship in Museum Practice at the Smithsonian Institution tries to find answers to this important question. It concerns everybody working with human remains and displaying his/her work to the public. First results are presented to inform the colleagues and to provoke discussion.

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Patterns of fission-fusion social organization in the mantled howling monkey (*Alouatta palliata*) in Nicaragua. L.A. WINKLER, University of Pittsburgh, Titusville, PA 16354.

Historically, mantled howling monkeys have been described as living in stable, cohesive social groups with unimale mating patterns. More recent evidence has suggested variability in social organization with group structure ranging from cohesive to a fission-fusion pattern. It has been suggested that the troop fragmentation that occurs with fission-fusion enhances foraging flexibility. However, many questions remain regarding fission and subgroup composition, movement and dispersal of subgroups, and reproductive consequences of fission.

The present study monitored group dynamics in a group of

mantled howling monkeys on the island of Ometepe, Nicaragua as part of an ongoing project of the Ometepe Biological Field Station. The home range of this group was approximately 20 hectares and characterized by dry tropical forest, heavily fragmented by agriculture and deforestation. All adult males (N=5) and the majority of the adult females (N=6) in the study group (total N = 21) were tagged as part of a capture-release project in July 1998. Group composition and proximity data were collected in January 1998, July-August 1998, and May-June 1999 using a combination of scan and focal sampling with a total of 148 hours of field observation.

The group functioned as a relatively cohesive unit, dispersing during the day for foraging but occupying proximal quadrants (30x30m) for sleeping during 60% of the study period. However, it fragmented into subgroups that remained separate for variable number of days (1-14) for the remainder of field observation. Size of the subgroups ranged from 2-19. Some individuals formed stable cores to subgroups such as 2 male-female dyads, which were together respectively 86% and 79% of time in 2 subgroups. Other individuals were variable in their subgroup location. When present, variation in subgroup composition was often linked to females who migrated between subgroups. Troop fragmentation appeared to maximize foraging strategies and facilitated monopolization of clumped resources. It would also seem to maximize the reproductive success of lower ranking males who are isolated with receptive females for prolonged periods of time.

Large population profiles - Palaeodemographic evidence from the Near East Bronze Age. U. WITTWER-BACKOFEN* and A. KEMKES-GROTTHALER** Institute of Anthropology: *University of Gießen, Wartweg 49, D-35392 Giessen; **University of Mainz, Saarstr. 21, D-55122 Mainz

The main source for palaeodemographic reconstruction is information derived from ancient skeletal remains. Often times this is the sole basis for the calculation of mortality statistics on the population level. The aim is to achieve a picture of past living conditions, including health and disease patterns, population structure, fertility and mortality profiles as well as population size. However, interpretation of individual life histories relies on several assumptions based on the population level, which are rarely fulfilled. Therefore, we have to consider that our sources represent merely a selection of those who did not survive. As our goal is to reconstruct the survivors, i.e. the actual living population, other avenues of research have to be pursued.

With large skeletal samples we have the unique opportunity to detect any postmortem selection effects which are responsible for sample reduction. During the past decade, several large population profiles were established

via standardized methods, which now provide us with more reliable data. This material was recovered from the Near East region, with representative numbers between 500 and 800 individuals per group. This allows for the direct comparison of population structures, and gives us information concerning the general variability of demographic parameters. These samples from the Near East can thus be useful for modelling the diversity of different living conditions in past populations.

Social networks in ring-tailed lemurs (*Lemur catta*) L.D. WOLFE, Department of Anthropology, East Carolina University, Greenville, NC 28757

Grooming is an important aspect of the behavior of many primates. Where it occurs, grooming is part of the communication system and it forms and maintains social bonds. The purpose of this research was to understand the social networks of a small group of habituated semi-free-ranging ring-tailed lemurs as manifested through grooming. The lemurs are housed in a large outdoor enclosure at the Duke University Primate Center. Each lemur has an identifying collar and tag.

It was possible for the observer to be stationed where all animals were observable during sessions of grooming. Data on grooming and the identity of the lemurs were collected in diary format and transferred to a spreadsheet for analysis. The results of the study suggest that most grooming is mutual grooming, males and females engage in mutual grooming on a regular basis, and male/male mutual grooming dyads were more frequently observed than female/female dyads.

Duke University Primate Center publication #695

The male Aurignacian crania from the Mladeč caves, Moravia. MILFORD H. WOLPOFF, Department of Anthropology, University of Michigan, Ann Arbor MI 48109-1382, DAVID W. FRAYER, Department of Anthropology, University of Kansas, Lawrence, KS 66044-2110, MARTIN OLIVA and JAN JELINÉK, Moravian Museum, Anthropos Institute, Brno, Czech Republic.

We present here the results of systematic comparisons and analysis of the adult male crania from the Mladeč Caves in Moravia, Czech Republic, discovered between 1882 and 1922. Archaeological associations and

the geological circumstances date these remains to the earlier Aurignacian of Central Europe. The Mladeč male crania show a mixture of features, some resembling Neandertals and others resembling more recent Late Pleistocene Europeans. Using these, a hypothesis of ancestry is evaluated for the sample, as this addresses issues of the fate of the European Neandertals and the origin of recent Europeans. We compared anatomical features and metric traits in the Mladeč males with the males from two potentially ancestral samples, Skhul/Qafzeh and earlier European Neandertals. Some features previously identified as Neandertal autapomorphies occur in the Mladeč males, indicating genetic contributions of Neandertals to these groups. Yet, Neandertals are unlikely to be the unique ancestors of these early Europeans. We show that it is not possible to exclude either the Skhul/Qafzeh or the European Neandertals samples from the ancestry of the Mladeč sample.

Paranthropus boisei: A derived eurytope? B.A. WOOD and D.S. STRAIT, Dept. of Anthropology, The George Washington University, 2110 G St. NW, Washington, DC 20052.

Although it is widely acknowledged that *Paranthropus boisei* is highly derived with respect to its craniodental morphology, interpretations of its paleobiology vary considerably. In particular, competing hypotheses suggest that it was either a dietary specialist, feeding on hard or fibrous foods, or a generalist, able to efficiently exploit a wide range of food resources. This study tested these hypotheses by determining whether morphological, ecological and evolutionary variables observable in *P. boisei* matched those expected to be found in dietary stenotopes and eurytopes.

Eleven variables were examined in *P. boisei* and other early hominids. These variables included 1) species diversity within clades, 2) species duration, 3) the existence of trends in species-specific characters, 4) evidence of sympatric species within a clade, 5) likelihood of experiencing vicariance or other biogeographic processes, 6) species distribution, 7) habitat preference, 8) species abundance, 9) degree to which morphology is apomorphic or plesiomorphic, 10) degree to which morphological adaptations allow or preclude exploitation of food resources, and 11) tempo and mode of evolution.

One variable (biogeographic processes) could not be adequately evaluated. All other variables were consistent with the hypothesis that *P. boisei* was a dietary eurytope, although some of these variables did not allow an hypothesis of stenotopy to be rejected. Two variables (species duration, existence of trends) were directly inconsistent with stenotopy in *P. boisei*, and two others (habitat preference, species abundance) were inconsistent with stenotopy unless particular conditions were met (namely, that the key dietary resource of *P. boisei* was abundant relative to the resources available to contemporaneous hominids, and that the key resource was present in both wet and dry habitats). On balance, these results suggest that *P. boisei* was probably a dietary eurytope. It had the ability to exploit hard and fibrous food sources, but also was able to consume many of the same foods as did earlier hominid species.

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Estimating stature from incomplete long bones: New standards from Guatemala. L.E. WRIGHT, Dept. of Anthropology, Texas A&M Univ., College Station, TX 77843, and M.A. VASQUEZ, Universidad de San Carlos de Guatemala.

We report new standards for estimating long bone length from incomplete bones for use in forensic and archaeological contexts in Central America. The measurements we use closely follow those defined by Steele (1970), but we add several new landmarks, and exclude points that we found difficult to identify. Instead of the multiple regression approach taken by Steele, we base the univariate equations on the total distance between pairs of points; they can be used when intermediate landmarks are eroded or unclear.

We measured the femur, humerus, tibia and fibula of 100 Mayan skeletons (68 males, 32 females) recovered from forensic exhumations by the Fundación de Antropología Forense de Guatemala (FAFG) and the Oficina de Derechos Humanos del Arzobispado de Guatemala (ODHAG). The sample includes skeletons from 5 ethnic groups (Achi, Ixil, K'iche, Kakchiquel, and Kekchi). Average stature (calculated using the Genovés femur standards) is 158.3cm for males and 147.1cm for females. Steele's formulae over-estimate femur length in this series by 5-10mm.

Following the recommendations of Konigsberg et al. (1998), we derive the equations by regressing bone section on bone length, and solve for bone length (classical calibration) to maximize the utility of the equations for taller populations. We generated equations for all possible pairs of points for males, females, and both sexes combined, but accept only regressions with $r^2 \geq 0.90$.

We test the male equations on 36 males of unknown ethnicity from El Chal, Petén (mean stature=160.8cm), that likely include both Mayans and ladinos. Mean differences between measured and estimated bone lengths are less than 1cm.

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The energetics of weaning: testing primate models of body and brain size ontogeny and evolution. H. T. WOOD, Department of Anthropology, University College London, Gower Street, London, UK, WC1E 6BT.

Weaning is a complex process that is associated with a variety of developmental, behavioural and social changes in the infant-mother relationship. While methods of determining age at weaning can be problematic, body weight at weaning is a more readily ascertainable parameter. Lee et al. (1991) suggest that relative to birth weight, body weight at weaning is constant across many mammalian species, weaning occurring once the infant has achieved four times its birth weight. This relationship reflects an energetic threshold above which the infant can no longer rely on the maternal milk yield to supply its energetic

needs, and also at which both metabolic and behavioural competence is possible.

The study presented here investigates the hypothesis that brain size at weaning also has important energetic implications. The demands of brain growth, and more importantly of brain maintenance, place a high energetic burden on the infant. This may be especially appropriate in the case of the primates, where the sub-adult brain consumes more than twice the energy than that of a similarly sized non-primate mammal.

This study examines the relationship between body weight, brain weight and weaning weight in various primate species for which data is available from the literature. It shows that, contrary to previous assumptions, brain growth can continue well after birth in these species, and that the cessation of this postnatal brain growth occurs just prior to weaning. The energetic demands of brain and body growth over the infancy period are modelled, taking into account the mother's contribution to energy intake via lactation, in order to investigate infant and maternal weaning strategies. The results are discussed in the context of evolutionary change in the primate body-brain size relationship, especially in the large-brained cebids and hominids.

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Get a life: androgens and the comparative endocrine architecture of life history in men. C.M. WORTHMAN, Emory University, Atlanta, GA.

Life history theory concerns design constraints informing species differences in the developmental, reproductive, and survival characteristics that define the life course. Species-characteristic lifeways reflect underlying strategies for allocation of two scarce resources, time and energy, among the biologically important tasks of productivity or growth, maintenance, and reproduction. The axiomatic allocation rule, that limited resources used for one purpose cannot be used for another, sharpens the trade-offs among competing life demands: schedules of resource allocation thus define life history construction. But life history theory begs the developmentalist question: how do organisms get a life? This report addresses the endocrine architecture of life history organization, or the role of the neuroendocrine-endocrine system in producing a life course. Specifically, it examines relationships of androgens to men's life history strategies.

Models of life history trade-offs for men have overlooked the diverse roles of androgens in human life history. Androgens originate from two endocrine axes—the bulk from the adrenals, the remainder from the gonads—and exhibit distinctive lifespan profiles of output. Although the regulation and functions of adrenal androgens (AA) remain incompletely understood, a characteristic AA trajectory marks each life history stage in both sexes and suggests a relationship to life history

architecture. Testicular output of testosterone, by contrast, contributes the principal bioactive androgen in adult men alone. The present analysis charts and compares life course androgen production by both axes in men, notes the functional correlates of each axis, and considers the implications for design trade-offs involved in men's life history strategies. Trade-offs among life history parameters (neuroendocrine regulation of a complex life course versus specific domains such as reproduction or maintenance) are examined in close physiologic detail, based in part on comparative population data on androgen profiles and life history variation (body size, timing of puberty) in men. Finally, these analyses shed light on the sources of elevated mortality risk in men across the lifespan.

Diet and dental health of elites at the Maya Site of Chau Hiix, Belize. G. D. G. WROBEL, Department of Anthropology, Indiana University, Bloomington, IN 47405

During the last two seasons of excavation at the Maya site of Chau Hiix, Belize, a total of sixty-nine primary burials were recovered from a single palace structure abutting the main plaza. The burials range from the Late Classic (c. 800 A.D.) to the Middle Postclassic (c. 1300 A.D.). Using only the sixty-one individuals that had teeth present, burials were placed in groups according to age, sex, time period (Classic or Postclassic,) and grave wealth. The dentitions were scored for wear, caries, linear enamel hypoplasias, calculus, and chipping. Several statistical models are explored in order to determine the effect social and temporal variables have on health and diet in ancient Maya society.

Though sample size is limiting factor, no distinct dietary or health patterns are discernable over time or between groups of individuals. Calculus, caries, and chipping are common throughout the series, though more prevalent in older individuals. Calculus levels are unusually high in both elite and commoner burials at Chau Hiix. Chipping is most common on the posterior dentition and is only severe in three individuals. Hypoplasias were frequent, though usually not severe. Dental variables do not change significantly over time, suggesting that elite diet and health at Chau Hiix remained stable between the Classic and Postclassic. The choice of mortuary goods appears to be related more to time period and age than to health or diet.

These results are compared to other Maya studies, which together indicate that traditional models of status used in the study of the ancient Maya are not consistent even within a single elite locality.

Hindlimb adaptations associated with heel-strike plantigrady in hominoids. R.E.WUNDERLICH, Dept. Biology, James Madison University, Harrisonburg, VA 22807, D. SCHMITT, Biological Anthropology and Anatomy, Duke University, Durham, NC 27710.

Development of a model for the origin of human bipedalism requires a comprehensive understanding of locomotor adaptation in both humans and extant hominoids in addition to an appreciation of the fossil record. Heel-strike plantigrady has been demonstrated to be a unique adaptation in hominoid primates, yet a suitable biomechanical explanation for this specialized kinematic pattern has not yet been presented.

We have quantified hindlimb angles at touchdown to test the association between heel-strike and hindlimb kinematic pattern in hominoids. Lateral view video sequences of 7 monkey species as well as 2 male chimpanzees were digitally acquired using Motus 4.3 (Peak Performance Technologies). Coordinate data for hip, knee, ankle and two reference markers were digitized with Motus and thigh and knee angles were calculated and compared across taxa.

Chimpanzees exhibit more thigh protraction (24°) at touchdown than the monkeys (average 53°), however hip flexion angle is higher in chimpanzees (74° vs. 45°) due to the upright position of the trunk. Knee extension is also greater in hominoids than in most monkeys, resulting in greater overall hindlimb protraction in the hominoids. Heel strike is associated with these limb positions because the downward shift of the ankle following heel strike attenuates vertical displacement of the knee (Inman, 1981). Midtarsal mobility retained for climbing in hominoids further precludes a forefoot touchdown posture in which the foot is used as a rigid lever.

Heel-strike plantigrady is associated with a hindlimb complex utilizing a high degree of thigh protraction and knee extension to increase stride length; this mechanism of increasing stride length is different in hominoids than in monkeys. Atelines manifest an intermediate condition in both hindlimb protraction and foot-strike pattern. It is hypothesized that this hindlimb complex is associated with adaptation for vertical climbing in which a high degree of hip flexion at the beginning and knee extension at the end of stance is necessary for maximizing stride length in a vertical environment. [NSF SBR 957078, 9520363, 9209004; Leakey Foundation; and Sigma Xi]

Dietary comparisons of Verreaux's sifaka in different microhabitats in Beza Mahafaly special reserve, Madagascar. N. YAMASHITA, Dept. of Anatomy, University of Hong Kong, Li Shu Fan Bldg, 5 Sassoon Road, Hong Kong SAR, China. nayutaya@hkucc.hku.hk.

Propithecus v. verreauxi (sifaka) was studied in the tropical dry forest of Beza Mahafaly. Parcel 1, a protected 80 ha. area, houses numerous individuals of four lemur species. The parcel has a range of microhabitats tending in a gradient, from a riverine, gallery forest in the east to a more xeric habitat in the west. Vegetation changes gradually from E to W. It was thought that differences in microhabitat might translate into dietary differences, both

in terms of composition and food toughness. The latter has consequences for interpreting the range of materials properties that sifakas can tolerate.

I followed six groups of sifakas (n=34) from February to December 1999. The groups were scattered throughout the parcel with roughly two groups each in the east, middle, and west. Ten-minute focal animal observations were conducted on collared individuals. Toughness, or the work of fracture, was measured in J mm⁻² with a portable tester. Scissors mounted on a platform are connected to a load cell, which feeds continuous force-displacement readings to a computer as the scissor blades cut through a food item.

Preliminary analysis revealed that there were no major differences in food toughness among the six sifaka groups. Groups located in the same section of the parcel (e.g., western groups) showed greater similarities to each other in the composition of their diets than to other sifaka groups. Despite these intra-region similarities, food toughness did not separate groups *inter-regionally*. There were a few plant species that the sifakas ate in common no matter where the animals were located in the parcel. These plants were not necessarily evenly distributed. It appears that sifakas tend to focus on foods within a range of toughness values, as the inclusion of food items common to all groups regardless of location attests. Further analysis may reveal more subtle differences among groups.

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AmpliTaQ Gold™ and ancient DNA samples.

D.Y. Yang^{1,2}, C. Savore¹, J.S. Wayne² and S.R. Saunders¹

¹Department of Anthropology, ²Department of Pathology and Molecular Medicine, McMaster University, Hamilton, Ontario, L8S 4L9, ³Department of Animal Biology, University of Pavia, Pavia, Italy.

The polymerase chain reaction (PCR) technique is essential to ancient DNA (aDNA) studies. But, PCR amplifications often fail because of degradation and impurities in ancient DNA samples. Recently, researchers have used highly efficient polymerases to amplify aDNA samples. AmpliTaq Gold™ from PE Applied Biosystems is one such polymerase.

In a study of human mtDNA from 2,000 year old Italian skeletal samples we have observed a strong boost of PCR amplifications using AmpliTaq Gold. But we have also found a significant increase in false signals indicating contamination and non-repeatable sequencing results

According to the manufacturer, AmpliTaq Gold™ can be used for up to 55-60 cycles. When 60 cycles were used, almost equally strong amplifications were observed for all samples, sometimes even with extract blanks. False positives should indicate systematic contamination with aDNA extractions but the sequences contradicted this. Reducing cycles to 40 resulted in variable strength amplifications and no false positives.

Another test of 20 samples used AmpliTaq Gold™'s time-release PCR amplifications with 350bp human mtDNA fragments for 60 cycles. All yielded strong

amplifications, but extraordinary differences from Anderson's reference sequence. Many of them could not be successfully repeated. Further experiments were carried out to understand the cause. Preliminary results suggest that lower amounts of template and higher sensitivity of AmpliTaq Gold™ resulted in more PCR amplification errors.

The notion that more cycles is better is not always right for aDNA research.

Supported by the Canada Foundation for Innovation, SSHRC Canada, and the National Museum for Prehistory and Ethnography "L. Pigorini", Rome, Italy.

Implications of a multi-gene phylogeny for strepsirrhine biogeography and evolution. **A.D. YODER**, Northwestern University, Chicago, IL

Genetic data, applied to questions of strepsirrhine phylogeny, continue to accumulate. The debate relating to the position of Malagasy dwarf lemurs (family Cheirogaleidae) should be considered settled: *all* DNA sequence data thus far examined are unequivocal in showing that dwarf lemurs nest comfortably within the lemuriform radiation. Many questions have not been resolved so satisfactorily, however. For example, the relationships among the primary Malagasy primate clades are far from resolved. Although the preponderance of evidence places the aye-aye (genus *Daubentonia*) at the base of a lemuriform clade, there are troubling discrepancies among data sets. These discrepancies point either to variable molecular-evolutionary phenomena or to episodic bursts of cladogenesis and stasis (or both) during strepsirrhine evolution. Taken as a whole, however, the genetic data argue forcibly for the hypothesis that the Malagasy lemuriforms are a single clade and thus the product of a single nonhuman-primate colonization of Madagascar. This hypothesis is thus far upheld by preliminary data from the cytochrome *b* gene for an assortment of extinct Malagasy primates, many of whom are morphologically diverse in the extreme.

The timing of the Malagasy primate colonization is still an open question. Although a published analysis of the cytochrome *b* gene suggests an early Eocene date of arrival, subsequent work by Morris Goodman and colleagues on the ϵ -globin gene proposes a more recent date. Work in progress is examining four genetic data sets (two nuclear and two mitochondrial) to test their congruence with either or both temporal hypotheses. The results will be significant for testing specific biogeographic models of primate dispersal.

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Post-burial Disturbance of Graves in Bosnia-Herzegovina. H.P. YORK, M.F. SKINNER, M.A. CONNOR, Department of Anthropology, Kent State University, Kent, OH 44242, USA.

In clandestine removal of bodies from mass graves, taphonomic data constitute the evidence. However, the temptation to infer that missing bodies necessarily bespeaks an illegal act must recognize that physical evidence in both mandated and secret exhumations is similar. Discriminating between these interpretations requires the highest standards of forensic investigation. This paper describes four sites in Bosnia-Herzegovina dating from the 1992-1995 conflict in the former Yugoslavia where bodies were found to have been inexplicably removed and compares them in terms of physical evidence with other monitored sites in which prior, non-contentious removal of bodies occurred due to body trading, mandated war-time exhumations, post-war body removals and transport, and unmonitored post-war exhumations. Both clandestine and mandated exhumations may be unskilled, careless and hurried. Distinguishing between these is difficult unless steps are taken to obtain: informant accounts, site topography (including artifact distribution) prior to excavation, mapping of all features, careful attention to stratigraphy especially grave cuts, and screening of gravefill.

Is *Morotopithecus* a Great Ape? N. YOUNG, Harvard University, Cambridge, MA, 02138 and L. MacLATCHY, Boston University, Boston, MA, 02215.

The phylogenetic relationship of the Ugandan Miocene hominoid *Morotopithecus* to fossil and living hominoids remains to be determined. In a cladistic approach, we used four published Miocene character sets: (A) Begun et al. (1997), (B) Begun & Güleş (1998), (C) Moyà-Solà & Köhler (1995), and (D) Cameron (1997). These datasets often had different characters and states to describe the same anatomy, so we resolved these conflicts, and where anatomy was not described, added characters. Postcranial regions were less well sampled than cranial so we also included our own postcranial characters. Separate parsimony analyses were performed on datasets comprised of five different combinations of characters and taxa: 1) (A) with *Morotopithecus*; 2) (B) with *Hylobates* and our own assessment of *Morotopithecus*; 3) (C) added to (A); 4) (D) added to (A); and, 5) postcranial characters from (A) and our own. The most parsimonious tree recovered in all analyses consistently placed *Morotopithecus* as sister to the extant great apes, with *Hylobates* sister to this clade. *Morotopithecus* was also consistently more derived than *Proconsul*, *Afropithecus*, and *Kenyapithecus* but less derived than *Oreopithecus*, *Sivapithecus* (only craniodentally) and *Dryopithecus*. These results imply that *Morotopithecus* is a primitive member of the great ape clade, but gibbons are believed to have branched off anywhere from 14-18 Ma while *Morotopithecus* is dated at >20.6 Ma. Possible explanations for this incongruence include: 1) the

Hylobates estimate is wrong and the origin of the great ape morphotype has been underestimated; 2) the similarities of *Morotopithecus* and great apes are homoplasies; and, 3) the characters used are inadequate. The latter conclusion is supported by the fact that despite the consistencies of the analyses, the addition of *Morotopithecus* and the use of different characters had a large effect on the placement of other Miocene taxa. This raises questions as to the robustness of the connections between any Miocene taxon and extant hominoids since different results can be achieved by changing either a few characters, or by adding a single taxon. Many of the characters used to estimate phylogeny may need to be reassessed.

New endocast reconstructions of *Australopithecus africanus* (type II and type III) from Sterkfontein, S.A.
M.S. YUAN and R.L. HOLLOWAY, Department of Anthropology, Columbia University, New York, NY 10027

The purpose of this study was to reconstruct two natural endocasts, which were originally named *Plesianthropus transvaalensis*, type II and type III. Found in Sterkfontein, they were first described by Schepers (1946). In the type II specimen, most of the frontal and right parietal lobes, and part of the left parietal and right temporal lobes, were preserved. The type III specimen lacks most structures except part of the parietal and occipital regions with obvious sagittal and lambdoidal sutures. Both endocasts show damage and distortion. Schepers estimated the cranial capacity of the type II to be 510-580 cc (1946) and 520-540 cc (1950), with no estimate given to the type III.

Duplicate plaster casts were dissected according to the pre-existing crack lines and distorted landmarks. For each endocast, the pieces were reassembled to reconstruct a more anatomically correct and complete endocast.

Our preliminary results are as follows: 1) The type II endocranial capacity as measured by the water displacement method provides an estimate of 457 cc. This estimate places the type II specimen well within the range of other *Australopithecus africanus* specimens; 2) The type III specimen is estimated to be 286 cc and is perhaps one of the smallest existing endocasts as compared to 310-320 cc of the juvenile AL 333-105 (Holloway, 1983). We note that as the sutures were very open, this specimen is most likely that of a young child. At the present, we have not yet drawn conclusions about the sulcal morphology on this type III specimen, which is very limited; 3) The type II specimen shows considerable convolutional details on the frontal lobe, which are under further study. We do not believe this region is fully chimp-like; and 4) In the type II reconstruction, the meningeal artery pattern was similar to that of the STS 60 and Taung endocasts.

Analysis of the relationship between subsistence strategy and human growth: a Predynastic Egyptian example. S. R. ZAKRZEWSKI, Dept of Biological Anthropology, University of Cambridge, UK.

Skeletal remains have been used to study disease, growth, and the manner in which they interact. Social

organisation can buffer this relationship and therefore modify human growth patterns. The transition to and intensification of agriculture is a period particularly associated with changes in disease prevalence and hence in growth. This period has been studied in Egyptian populations as it is well known historically and provides a sufficiently large skeletal sample to assess.

Hunter-gatherers had to cope with diseases such as head and body lice, pinworms, yaws, malaria, some protozoal and bacterial infections (such as *Salmonella typhi* and staphylococci). Early agriculturalists were also affected by "new" zoonotic diseases, including sleeping sickness, tetanus, scrub typhus, tularaemia, relapsing fever, trichinosis, leptospirosis and schistosomiasis. As a result, populations undergoing a shift from foraging to agriculture show an increase in caries, periostitis, and osteomyelitis. Nutritional quality declines, due to the increased concentration on fewer foodstuffs, placing individuals at greater risk of infection, thus affecting bone growth. Although growth occurs in childhood, and growth retardation occurs particularly in early childhood, its effects can be seen throughout adulthood in adult stature and body proportions.

Osteological and palaeopathological methodologies were used to gather data as to the health and growth patterns in Predynastic and early Dynastic populations, using Martin-Saller postcranial and Howells' cranial measurements. Paleopathologies and other stress markers were also noted. The populations studied include the Badarian, the Predynastic from Naga-ed-Dér cemetery N7000 and the early Dynastic from Abydos. This work assesses the changes in long bone growth through the Naqada periods and compares them with the early Dynastic periods. In this way the reduction in stature and other lifestyle effects associated with the transition from Predynastic to the Dynastic can be considered.

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Preliminary data on impaired placentation during pregnancy at high altitude: Is the placenta a target of natural selection? S ZAMUDIO, C BLANFORD, A GRILLI, P LEE, MC TISSOT VAN PATOT. Dept. of Anthropology/Program in Health and Behavioral Sciences, Univ. of Colorado at Denver; Dept. of Anesthesiology, Univ. of Colorado Health Sciences Ctr., Denver CO 80262

There is a gradient in the magnitude of intrauterine growth retardation (IUGR) observed between human populations at high altitude. Birth weight approximates sea level values in Tibetans, averages ~250 grams in Andeans and ~375 grams in Europeans residing at 3,000-3800 m. This gradient suggests that evolution may be occurring to favor sea level normal birth outcomes in populations with a longer history of residence at high altitude. Our long-term research tests the hypothesis that the placenta has been subject to evolutionary pressure and consequent change in high-altitude populations, and that these changes, in turn, result in more favorable birth outcomes.

Uteroplacental arteries (UPA) are remodeled during pregnancy. Smooth muscle cells (SM) and endothelium (EC) are destroyed and replaced by placental cells (trophoblasts - TR). The arteries that supply the placenta are thus converted to flaccid conduits providing continuous blood flow to the placenta. Failure of this remodeling has been

linked to pregnancy complications, including preeclampsia and IUGR, both of which occur more commonly among Europeans residing at high altitude. Recent *in vitro* evidence indicates that oxygen tension plays a key role in guiding TR invasion. We thus predicted that placentas from Europeans at high altitude, whose birth outcomes are the most compromised, would have decreased TR invasion.

Four randomly chosen sites with basal plate (containing UPA) were dissected from placentas obtained from 4 high altitude (3100 m) and 6 low altitude (1500 m) normal pregnancies in Colorado, USA. The tissue was snap frozen in liquid N₂ without fixation. Four sections (10 μ thick) were obtained from each site. Triple-antibody immunocytochemistry was used to stain for SM (alpha-actin), EC (Von Willebrand's Factor) and TR (cytokeratin). 21 and 20 UPA were analyzed in high and low altitude placentas, respectively.

	TR	EC	TR+EC	EC+SM
1500 m	55%	30%	10%	5%
3100 m	43%	43%	0%	14%

High altitude placentas show evidence of decreased UPA remodeling relative to low altitude placentas, supporting the hypothesis that the lowered O₂ tension characteristic of high altitude may impair placentation. Further investigation of between-population differences in placentation would be fruitful. (Supported by the American Heart Association, grant-in-aid to Dr. Zamudio.)

Primate muscle insertions: What does size tell you? A.C. ZUMWALT¹, C.B. RUFF¹ and C.A. WILCZAK².
¹Department of Cell Biology and Anatomy, Johns Hopkins University School of Medicine, Baltimore, MD 21205 ²Villa Julie College, Stevenson, MD 21153

Muscle insertion marks have been used to assess activity levels in human archeological samples. However, a quantitative comparison of muscle insertion (MI) morphology in nonhuman primate species with different locomotor patterns has not yet been performed. Such a study is a necessary prerequisite for reconstructing fossil primate behavior from MI morphology. This study compares four muscle insertions with respect to body weight and midshaft diaphyseal bending-torsional strength (J) in eight primate species, including great apes, New World and Old World monkeys (n=48). Whenever possible, three males and three females with known body weights were included for each species. When associated body weights were not available, sex/species means from the literature were used. The J of each bone was available from previously obtained computed tomography (CT) scans for three-quarters of the sample.

Two-dimensional images of the deltoid tuberosity, radial tuberosity, femoral lesser trochanter and tibial tuberosity of each individual were captured on videotape. The areas of these MI's were measured using NIH *Image*. Repeated measurements of the same MI's indicate reproducibility to be within 5-7%. However, MI boundaries for the deltoid insertion were unreliable in some species so this insertion was excluded from further study.

For the three remaining muscle insertions, MI area is significantly correlated with body weight ($r^2 = 0.70$ to 0.89). The radial and tibial tuberosities scale isometrically with body weight, while the lesser trochanter scales with slight positive allometry. The size of MI areas relative to body weight does not appear to distinguish between locomotor groups. However, a comparison of MI area to J shows that arboreal species have lower bending-torsional midshaft

strength (J) when compared to quadrupedal species with similar MI areas. Assuming that MI area is proportional to muscle size, this suggests that the limbs of quadrupedal species are subjected to greater bending-torsional loads for a given muscle size.

This study shows that it is possible to reliably identify and measure some muscle insertions in nonhuman primates, although the deltoid tuberosity could not be reliably measured in our sample. For the muscle insertions and species included in this study, MI size primarily scales with body size and is not useful for distinguishing locomotor patterns. However, the relationship of MI area to the bone's diaphyseal strength may be indicative of locomotor behavior.

Trabecular architecture of metacarpal heads in catarrhines: A preliminary report. M. Zylstra, Department of Anthropology, University of Texas, Austin, TX 78712

Studies of trabecular bone tissue have demonstrated that its mechanical properties are largely a function of bone density and orientation, and that these properties are directly influenced by stress magnitude, loading direction and anatomic location.

The present investigation examines the nature of metacarpal trabecular morphology in a sample of extant genera (*Pan*, *Hylobates*, *Papio* and *Homo*) and its relationship to manual loading in differing locomotor styles. It is predicted that *Pan* (a knuckle-walker) and *Papio* (a digitigrade quadruped) share similar patterns of trabecular orientation and bone volume, since the metacarpal heads are habitually loaded in compression along an uniaxial plane. To conduct the analysis, high resolution x-ray computed tomography of the distal joint using slice thicknesses of 46 μ m was carried out. This method enables 3-D reconstruction and measurement of bone volume, trabecular plate number, size and orientation.

Given that elevated bone density or increased cortical thickness is associated with areas of high stress magnitude, and orientation of trabeculae corresponds to the direction of principal stress, the findings of this study suggest several things. Gibbon metacarpals are subjected to multidirectional stresses, however forces applied in tension may effect a morphological response that differs from loads applied in compression. High trabecular bone density and number, as well as anisotropy in a dorsoventral direction across the metacarpal head, is consistent with digitigrady in *Papio*. *Pan* trabecular morphology reflects high, unidirectional stresses sustained primarily across the ventral portion of the joint rather than dorsally, which might be expected in a joint typically loaded in a position of hyperextension during knuckle-walking. This would indicate greater and/or more frequent forces incurred during activities such as climbing, or that forces generated through the flexor tendons and glenoid plate in knuckle-walking posture have a significant impact on trabecular architecture. Finally, human metacarpal heads show very low bone density dorsally, and minimal anisotropy ventrally, consistent with varied grasping activities involving flexion of the digits, but which do not generate extreme forces.